
GOVERNMENT OF INDIA

HOME DEPARTMENT

NEW CAPITAL AT DELHI

PRELIMINARY REPORT AND ESTIMATE

BY THE

ENGINEER OFFICERS ON SPECIAL DUTY

IN

THE HOME DEPARTMENT

Dated 1st October 1912

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NEW CAPITAL, DELHI.

Forwarding note dated 8th October, 1912, by Mr. G. F. de Montmorency, I.C.S., officer on special duty in the Home Department of the Government of India.

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Forwarding note dated 8th October, 1912, by Mr. G. F. de Montmorency, I.C.S., officer on special duty in the Home Department of the Government of India.

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Introductory.

1. It is unnecessary to add much to the mass of useful material which has been collected by Mr. Ward and his staff in regard to the preliminary estimates of the cost of the New Capital. I propose to confine my remarks to a rapid survey of the estimates as a whole, and to proceed to discuss—

(*a*) Of what the estimates consist.

(*b*) The purpose for which the estimates were made.

(*c*) The salient details of each of the estimates.

(*d*) The possible utility of the estimates to the Government of India.

(*e*) Pertinent suggestions in Mr. Ward's note.

The contents of the estimates.

2. The estimates only concern the Imperial City. The estimates dealt with by Mr. Ward cover—

		Rs.
I.	Land	22,49,365
II.	Storm water drains, sewage and sanitary installation ...	29,85,000
III.	Irrigation	41,54,887
IV.	Domestic water-supply	13,56,044
V.	Roads	24,38,105
VI.	Parks	8,38,000
VII.	Buildings	2,64,90,242
VIII.	Lighting	30,16,449
IX.	Establishment	50,59,573
X.	Tools and Plant	6,00,000
	Grand Total ...	5,01,87,655

Contingencies are included in each separate estimate. Furniture is not included for the reasons mentioned in Mr. Ward's report. Rs. 10,00,000 may be roughly assumed as the probable cost of this item. No allowance has also been made for excess or unforeseen expenditure. This can hardly be placed at a lower figure than 10 per cent on the total of direct outlay on works, which is 10 per cent on Rs. 4,35,28,082. This addition brings up the total cost to Rs. 5,56,40,463.

Of course several items have not been included in these estimates which have a connection with the imperial city. I refer to items such as the afforestation of the ridge, river training and provision in the most complete form of hospitals, universities, etc. The afforestation of the ridge and river training have, it may be urged, a slight connection with the new settlement; but neither of these works fulfill an immediate purpose to satisfy a pressing aesthetic or utilitarian need of the city. River management and the cleaning and levelling of unhealthy low lying river *belas* is already an accepted policy on which money is being expended in the present city of Delhi. The afforestation of the ridge is a matter for forest management analogous to the treatment of any other rakh which is Government property and the afforestation of which is part of an accepted administrative policy of economic or climatic improvement of the country. Immediate needs have been provided for to meet sanitary, medical and educational requirements in the new city: but medical colleges, universities, and other developed expressions of sanitary and educational activity are general administrative

improvements to be provided from the general expenditure of Government in these directions in India. This immediate provision is not a first charge for any urgent aesthetic or necessary consideration in connection with the New Capital.

A somewhat obvious criticism has been made in regard to these estimates that, as the lay out has not been selected, these estimates are useless even for the purpose of preliminary estimates. At first this argument seems to have some force; but I think it is a simple matter to dispell any doubts to which it may give rise. The experts have recommended a site for the new imperial city. Their recommendations have received the approval of the Government of India and the Secretary of State. The result is that it has been decided that the new city will be within certain fixed boundaries on the map, North, South, East and West. During the summer as a result of much enquiry from the various departments of the Government of India, we have ascertained, with a few unimportant exceptions, what offices and what officers will be located in the imperial city, and what accomodation will be required for them. The number of items, for which space is to be found in the new city have been drawn out criticised and determined. The size of the compounds and areas has been settled which is to be allotted to each of these items. The result is we have a certain number of data of a certain size to be filled in in a certain space within certain boundaries. The uncertain elements are thereby eliminated. There can only be a limited number of ways of draining and providing water and irrigation to the collection of data accommodated on the particular site. There can be only a certain number of blocks in which the data, however arranged, can be put together on the site. The length of roads, sewers, drains, remains, therefore, fairly constant for any lay out. However much the bits of glass in a kaliedoscope are shaken together, in the ensuing arrangement the space occupied is the same, and the component parts of the re-arrangement are similar. The arrangements suggested in my note of 24th August, 1912, for fitting all requirements into Mr. Lanchester's last lay out have been taken as the basic arrangement for preparing the preliminary estimates: and the fact that this particular lay out or arrangement within the lay out is unlikely to be ever adopted in practice, in no way vitiates the approximate accuracy of the preliminary estimates.

The purpose for which the estimates were prepared.

3. The estimates were prepared in the first place for the information and guidance of the experts, who left a special request for their preparation in their note of "advice as to information to be collected." In a later part of this note I have ventured to suggest directions, in which the estimates, may, even at the present stage, be of use to the Government of India; but in studying them I would venture to request that the original purpose for which they were prepared be not lost sight of. Those who have collaborated in their preparation may in connection with their immediate purpose have to extend their investigation into further ramifications and alternatives or make a radical change in some items according as the experts desire or advise; but the estimates stand on the basis of being material supplied to the experts for use in constructing their final project and are intended to serve as clay in the hands of the potter for the experts.

The estimates.

4. The estimates fall into two classes, the necessary and the aesthetic. By these terms my meaning is that there are certain items so necessary that if they are not provided in the best possible manner, the city cannot come into existence as a settlement which can be inhabited as an imperial city at all. Into this class fall the estimates for land, storm water drains, sanitation, irrigation and domestic water-supply. The expenditure in the case of these estimates is to be directed to ensure that the best and most efficient result possible is to be assured. In the aesthetic division of the estimates, roads, parks, buildings and lighting may be placed. There is in these cases a minimum which would provide for the needs of the city, but the maximum is entirely a matter which depends on the amount of money which can be spared for the aesthetic result. For example it would be a counsel of perfection to have the majority of the roads with a tar macadam surface, and the majority of streets and residences lit with electric light and the majority of the parks completely "lawned" and decorated with gardens and the best kind of shrubs, and the majority of buildings as fine and decorative as possible, and there is no limit to the money which might be spent on these objects; but

while no one wants the city to be little better than an ordinary cantonment in appearance, few would say that the imperative needs of the situation demanded such an aesthetic expenditure as I have sketched above.

I will now proceed to discuss the estimates.

Land.—Rs. 22,49,355.

The sizes of compounds and the list of component parts and areas of different items of the imperial city having been criticised and determined by the Government of India, the amount of land required has become a fixed and unchangeable item. The cost sum, as entered in the estimate, is according to the Collector's estimates. The possibility of his awards being subsequently increased in civil litigation, is one of the strongest arguments for having an allowance for "excess and unforeseen expenditure."

Storm water drains, sewage and sanitary installation.—Rs. 29,85,000.

The site of the city is naturally well situated for disposal of both storm water drainage and sewage. Perhaps the only physical defect is the fact that physically it is convenient to outfall both storm water and sewage into the low land towards the river at one spot. The localised treatment of the scheme at this point may be difficult and involve some further expenditure. In this estimate it is necessary that the arrangements should be as perfect as possible as the health and the comfort of the new city depend very largely on the efficiency of these arrangemets. It is also necessary that the scheme should be a comprehensive one and that the storm water and sewer system as a whole should in its outfall and main sewers be of a magnitude to absorb the whole system eventually, though individual portions and sub-connections may not be taken in hand or made for a number of years and it is with this end in view that the estimate has been made.

There are two points for special comment. The extent to which water borne sewage will be used, *i. e.*, the question of the extension of the water closet system of sanitation to the meaner classes of dwellings is a matter for consideration as affecting the estimate totals. It has been assumed that the extension will be general—The item "sanitary installation" including dry rubbish carts, incinerators, latrines, water carts, urinals, washing places and dhobi ghats are for discussion. Wherever the Government of India resided, it might be assumed that a local body assisted or unassisted by government grants for sanitation would have to provide a new installation of this kind to meet the recurring needs of the Government of India and its establishment. It is questionable whether, therefore, these items amounting to some 6 lakhs of rupees are a proper charge to initial expenditure on the imperial city. As the taxation of the imperial city will not in its early years provide an income of sufficient resources from which such an initial installation can be made, the cost will almost certainly be met from imperial funds. Whether it should be a charge to the head of the new imperial city or to the funds from which the Government of India make sanitary grants, is a matter for the decision of the Government of India.

Irrigation.—Rs. 41,54,887.

The climate of Delhi makes the provision of efficient irrigation a necessity. The new city can never be green, and dust would render residence most intolerable without an efficient irrigation system. Mr. Ward's note is the result of an expert's examination of the following possible sources:—

(*a*) Flow irrigation from the Western Jumna Canal,

(*b*) Pumped irrigation from water provided by the Western Jumna Canal,

(*c*) Subsoil water,

(*d*) A gravitation supply from the hills,

(*e*) A pumped water-supply from the river Jumna.

For many years to come a Western Jumna Canal supply is an impossibility. If the Sarda-Ganges scheme is eventually made, and the whole Western Jumna Canal system is altered, this may be a possibility but this source of supply is a sealed book for numerous cogent reasons but for that eventuality. Except in a small part of the tract where tube wells may give an auxiliary supply, the excellence of the slope both of the surface and subsoil drainages which is such a boon to us

in the matter of sanitation, effectually prevents the collection of subsoil water in any quantity to serve as the basis of an extensive irrigational supply. The gravitation supply from the hills was worked out at considerable labour; it has had to be rejected as outside the realms of possibility as its total probable cost amounts to more than the total of the whole of the estimates for all the items of the imperial city. The only alternative left is a pumped supply from the river Jumna. In the estimate this has been taken from the Jumna at a point below the present city near to the new city. A comparative estimate has still to be made whether it would be well to have only one installation and pump irrigation water from the same place as the domestic water-supply above the present city and further away from the new city. In the interests of sanitation and economy of water the distribution system has been made a somewhat expensive one. Open earth channels will no where be used. Recurring cost is an important item in this estimate and efforts have been made to keep this as low as possible.

It is to be noted that the estimate does not provide for—

(*a*) the irrigation of the cantonment area,

(*b*) irrigation for the afforestation of the ridge.

If this is to be included, the cost both initial and recurring will be much greater.

Domestic water-supply.—Rs. 13,56,044.

In this case as in the case of irrigation the estimate has been arrived at after an investigation of various sources of supply and a careful consideration of recurring cost. A supply pumped from the river has been accepted as the only possible solution of the problem. This being so there is only one place in which the installation can be placed, that is upstream from the city at a point where the river is tied by physical features to a particular spot and is unlikely to move away from the expensive installation. The mains and tanks for a pumped supply for domestic purposes in cantonments are allowed for in the system, but the share of the cost to cantonments is not included in the estimate totals.

We now come to the aesthetic estimates.

Roads.—Rs. 24,38,105.

The widths proposed by Mr. Ward are 200′, 80′, 60′, 50′, 40′, 12′, instead of the widths allowed by Mr. Lanchester ~~of 250′, 150′, 120′, 80′,~~ 60′ 12′, Mr. Ward gives his widest avenue a somewhat better surface coat than Mr. Lanchester; but in most cases the surfaces proposed by Mr. Ward are much lighter than what Mr. Brodie spoke of when he was investigating the needs in the way of roads No tar macadam surface has been allowed for in the cost of laying of the roads. Mr. Ward has included the *bela* road and ridge roads which are corollaries rather than necessities of the new imperial city road system. The recurring cost and wear and tear of the roads generally is not likely to be much, as the heavy traffic of the city will be carried by diversion roads. Mr. Ward's arboricultural estimates are on a very liberal scale; he allows for a tree every 30 feet and a double row of trees for the main avenues. The tree planting on an ordinary avenue with a single row of trees comes to Rs. 1,056 per mile and for all the avenues to Rs. 1,15,600. I have had a great deal of experience of tree planting and I think in practice we may find we can carry out this part of the road making for half that sum. It will be seen that this estimate is capable of infinite increases and rearrangements. If we go in for broader roads with a heavier surface and tar macadam the cost might nearly be doubled. Some savings are also possible, *e.g.*, there are 34 miles of 80′ road and 30 miles of 30′ road. If we have 64 miles of 50′ road and strike out the 80′ calculation altogether a large saving is the result.

Parks.—Rs. 8,38,000.

Here too the estimate is on a fairly lavish scale. There is no limit to what could be spent per acre on parks. The amount of "wild" "or intensive" park is the factor. The figure of Rs. 600 per acre allows for a fairly heavy proportion of intensive park. No doubt a fairly picturesque park can be made for Rs. 300 per

acre. The greater proportion of intensive park there is, the greater will be the recurring expenditure. The city is going to depend in a large measure for its beauty on its parks, avenues of trees and gardens, so the estimates for parks has been kept at a liberal figure.

Buildings.—Rs. 2,64,90,242.

Here too, if we are to secure aesthetic results, there is practically no limit to what might be spent on buildings. The plinth area rates adopted do not represent the sums for which the buildings could be erected which would be much lower, but the reasonable limit which can be allowed to the architect and engineer if a fairly good building is to be erected. The staff have consulted several authorities with a long experience of large buildings in India and have had curiously different opinions on the rates adopted, some holding the rates adopted to be adequate and likely to allow for fine buildings, and others holding that we shall never get public buildings worth looking at with rates like this. My own opinion is that so far as Government House, the Secretariats and the public buildings are concerned we have trimmed our wings too much. The bungalow rates, of course are dictated to some extent by the return on capital from the rent and the necessity of trying that an officer or official shall not pay more than 10 per cent of his pay for the whole year both for his Simla and Delhi house accommodation. The estimate for residences can be considerably reduced by two devices:—

(*a*) By assuming that of the deputy secretaries, under secretaries, a certain portion will be able to find accommodation in hotels, clubs, etc., or by not providing for all the clerks and peons but assuming that private enterprise will step in and have premises to let for them.

(*b*) By letting contractors step in and build some of the minor residences in the manner suggested in my note of 24th April, 1912 (Home department. Delhi Deposit. Proceedings May, 1912, No. 3.)

Lighting.—Rs. 30,16,449.

As far as the fittings in rentable buildings are concerned Mr. Meares kindly give his help in the preparation of this estimate and this item is reliable. The power installation estimate is however a non-professional one and is unreliable, *e.g.*, Rs. 18,000 for Government House is probably under the mark. Mr. Pitkeathly kindly promised to help in its preparation but was prevented from doing so by illness. It would be well, when he recovers, to get a more reliable estimate from him. The object here is to ascertain what it would cost Government to put down an installation and at what cost it could supply a unit of electrical fluid. When this has been ascertained, the offers of private firms can be considered. If their charge for a unit over the cost of supply of a unit from a Government installation only works out to a sum which is less than the interest on the capital cost of a generating station to Government, it is clearly profitable to Government to close with a reliable firm.

Tools and plant.—Rs. 6,00,000.

Establishment.—Rs. 60,59,573.

Tools and plant has been calculated at 1½ per cent. This item depends greatly on the quality of the business management of the engineering control. Some stock will be available from Temporary Delhi. Establishment charges work out at 14.75 per cent. In some works 23 per cent is allowed; but here the work and control will be concentrated in a small space and travelling allowance and reduplication of staff to cover wide areas will be obviated.

The use of the estimates to the Government of India.

5. I have explained in paragraph 3 of this note the immediate purpose for which these estimates were prepared. The Home Department and the Finance Department have already expressed a desire to see them. I venture to think they may be of use to give the moral conviction to silence one particular form of criticism in regard to the new city. Criticism has been abundant of the

nature which described new Delhi as the little cloud no bigger than a man's hand in the horizon of finance which was to deluge the country in a down pour of extravagant expenditure. I think the perusal of these estimates will convince those who may wish backing to refute such cavils, that while individual estimates may be increased by a few lakhs, it is quite impossible with ordinary economy that the bill could ever exceed some figure between 4 and 5 million pounds, and that the suggestions of 12 millions belong to the limbo of hasty and hyperbolean criticism.

The problem of most work estimates of anything like this magnitude in India (which are generally canal or railway estimates) is almost entirely one of capital expenditure and profit with certain ulterior consideration of advancement of public perosperity. The problem of these estimates however is almost entirely one of striking the due balance between the necessary and the aesthetic. If money is allotted eventually to cover the necessities only, we shall not even obtain a glorified cantonment. It is quite possible on the other hand to push the consideration of the aesthetic side to the limits of unwarranted extravagance. It is hoped that these estimates will give an opportunity for consideration, before the experts put in their final scheme, concerning the amount of money Government is prepared to allow for each item in the new city. Is Rs. 50 lakhs sufficient for the residence of the head of the Government of India in the new imperial city? Is Rs. 86,03,000 sufficient for the secretariats of the Government of India when we consider that these will be the main—almost the only large blocks of public buildings affording opportunities for architectural elaboration in the new city? These are types of the questions which press for solution before the Government of India come to consider the final report of the experts and the sums which they propose for expenditure on different branches of the new city. The formation of a policy in regard to these considerations and a technical elaboration, criticism or reconstruction of these estimates professionally by the Chief Engineer of the new city and the Government of India in the Public Works Department pending the receipt of the formal recommendations of the experts, would, it is submitted, enable the Government of India to have material ready with which they could at once on receipt of the experts' final report take up the report without further delay and form with little trouble a project estimate for carrying out the building of the new city, on which the Secretary of State would be able to pass orders. Unless some such considerations take place in the time which intervenes between the receipt of these estimates and the receipt of the final report of the committee of experts, great delay must ensue on receipt of that report before it can be criticised adequately and before a complete project can be sent for the sanction of the Secretary of State.

Pertinent suggestions in Mr. Ward's note.

6. Mr. Ward's note on the programme of construction gives an idea of the largeness of the scale on which the operations for building the new imperial city will be, and the amount of arrangement which will be required to get out a programme on the most economic yet efficient lines for construction and the smooth organisation of supervision and labour. It would appear that the appointment of the Chief Engineer, who is to control the work eventually, might well be made in December so that he may be able to get acquainted with the final details of the project as a whole, before he has to help in compiling the project estimates, and to get out his scheme for the collection of materials, staff and labour. About the same time it would not be amiss to arrive at a decision as to the executive controlling authority which is to arrange for the carrying out and development of the imperial city project scheme. If such arrangements are provided for in time, there will be no delay or hitch in the operations by which the new Delhi is to arise phœnix like from among the ruins of the Delhis of the past.

G. C B. P., Simla.—No. 708 H. D.—13-11 12.—55—N M.

PRELIMINARY REPORT AND ESTIMATE.

GENERAL REPORT.

NEW CAPITAL, DELHI.

PRELIMINARY REPORT AND ESTIMATE.

General report dated 1st October, 1912, by Mr. T. R. J. Ward, C.I.E., M.V.O., Superintending Engineer, officer on special duty in the Home Department.

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G. C. B. P., Simla,—No. 708 H. D.—13-11-12.—55.—J.K.

NEW CAPITAL, DELHI.

General report dated 1st October 1912 by Mr. T. R. J. Ward, C.I.E., M.V.O., superintending engineer, on the preliminary reports and estimates for building the new Capital at Delhi.

Introductory remarks.

From early in April when the collection of information for the Committee of Town Planning Experts and the surveys of the sites began, the staff have spared themselves no pains to make estimates of the probable cost of the varied engineering operations that are required to make a city comfortable and convenient as well as fine. During the time that the experts were at work in India the estimates were seldom put on paper but thrashed out in the committee room ; busy professional men at home being content to collect facts and opinions rapidly by personal interviews, and to act on them. This method of working enabled great progress to be made, but it threw a heavy load of responsibility on the younger officers who had to be ready at a moment's notice to deal with any aspect of their subject in a clear, accurate and logical way, so as to command the confidence of the Experts from Home, who would have been very much hampered had their staff proved deficient in powers to grasp quickly the immediate needs of their line of thought, and still more so if they had asked for time to write out what was required of them. Nevertheless a large number of facts connected with the difficult subject of irrigation, water supply and railway diversions and several difficult approximate estimates were worked out during the hot weather while the Committee were on the spot, and a large amount of field work was done by the engineers and their subordinates as well as by the Survey of India staff.

A flying start at getting out a complete set of preliminary estimates and reports was made as soon as Mr. Lanchester left Delhi, and after two months unremitting labour these are now ready for submission. It was felt that to be of real service the estimates must be delivered as quickly as possible, and the temptation to put forward all the information collected was as much as possible resisted, as it was felt that the small staff of earnest and zealous workers might overwork themselves, and it being the sickly season of the year, the enterprise be brought to nought by fever. Moreover the main purpose of the reports is to supply such preliminary information as will enable instructions to be issued that will lead to the rapid preparation of a detail project by a competent staff of carefully selected skilled engineers. If the estimates have been conceived and worked out with prescience and a right understanding of their object, and it is believed that they have, this will enable Government to come to an early decision as to the sums of money that should be allotted to each one of the various operations that go to make a city an economical, healthy, convenient, comfortable as well as fine one to live in. It should be possible to say now what should be spent on buildings, compounds and roads, and on their drainage, irrigation, and lighting to obtain a well-balanced effect. This done, a project estimate has to all practical intents and purposes been prepared. Indeed it is difficult to see how else to proceed; architects must know what sums may be spent on providing the accommodation required. If Government know the accommodation needed they can definitely allot sums for the construction of the buildings. This sum becomes the project amount ; the plans will take time to prepare, but must provide buildings within the sanction. Similarly the extent to which building areas are to be developed in the first instance will largely determine the expenditure to be incurred on roads, parks, the drinking water supply, irrigation, drainage and lighting, and after due consideration of the relative cost of each of these engineering operations, projects can be prepared laying down the sums to be spent on each, beyond which development must not go. This done, all will be ready to draft in a proper staff of engineers to get out the detail plans for the approval of the chief engineer, and the construction of the city can be rapidly and economically proceeded with. To this end each estimate is based on the measurements that can now be made, and each report explains the circumstances of the operation dealt with in the estimate, and draws attention to points on which instructions can be usefully given, so that the estimating may be confined to what is needed, and the staff saved from exhausting themselves in thrashing out useless alternatives ; these waste time and money and are killing to earnest men. A programme of work and a schedule of rates is also supplied to facilitate the scrutiny of the proposals.

THE ESTIMATES.

The totals of the ten estimates by main heads of expenditure.

2. With this preamble the estimates, ten in number, are contained in the following statement that explains itself.

Estimate number.	Name of estimate.	Particulars of estimate. — Names of sub-estimates.	Cost Rs.	Total cost of each estimate. Rs.	Name of officer who prepared each estimate.
I	Land	Acquisition of Block B	14,86,845	...	Major H. G. Beadon, I.A., Deputy Commissioner, officer on special duty with the Government of India.
		Acquisition of Block E	7,62,510	...	
				22,49,355	
II	Storm water drains, sewers and sanitary installation.	(a) Storm water—			
		Main outfall drain	4,00,000	...	Mr. T. R. J. Ward, C.I.E., M.V.O. and Lt. G. E. Sopwith, R.E. engineer officers on special duty in the Home Department.
		Tributary drains	11,00,000	...	
		(b) Sewers—			
		Sewers	5,25,000	...	Mr. T. R. J. Ward. C.I.E., M.V.O. and Mr. H. E. Parker, Assistant Sanitary Engineer. engineer officers on special duty in the Home Department.
		Sewage farm	30,000	...	
		Manholes etc., syphons inlets, outlets, ventilation, flushing and outfall.	2,45,000	...	
		Unforeseen	55,000	...	
		(c) Sanitary installation—			
		Dry rubbish carts	3,75,000	...	Mr. H. E. Parker, Assistant Sanitary Engineer. engineer officer on special duty in the Home Department.
		Incinerators	1,00,000	...	
		Latrines, water carts, urinals, washing places and dhobi ghats.	1,55,000		
				29,85,000	

III	Irrigation	Pumps	4,32,000	...	Lieutenant G. E. Sopwith, R. E., engineer officer on special duty with the Government of India. This officer also prepared the first drafts of those parts of the general report that deal with estimates Nos. IV, V, VI, VII and VIII.
		Reservoirs	65,680	...	
		Rising mains	15,59,480	...	
		Distributing and service pipes ...	15,69,110	...	
		Valves	1,50,000	...	
		Contingencies	3,77,717	...	
				41,54,887	
IV	Domestic water supply...	Unfiltered water supply	1,33,140	...	Mr. H. E. Parker, Assistant Sanitary Engineer, engineer officer on special duty in the Home Department.
		Purification plant	1,32,250	...	
		Filtered water supply	1,69,500	...	
		Rising mains, valves, meters	3,00,684	...	
		Service reservoir	50,000	...	
		Distributing system	5,46,460	...	
		General items and preliminary expenses ...	23,830	...	
				13,56,044	
V	Roads	Road surfaces	16,88,181	...	Captain W. H. Roberts, R. E., engineer officer on special duty with the Government of India.
		Earth and rock work	2,27,007	...	
		Culverts	5,22,917	...	
				24,38,105	

Estimate number.	Name of estimate.	Particulars of estimate.		Total cost of each estimate.	Name of officer who prepared each estimate.
		Name of sub-estimates.	Cost		
			Rs.	Rs.	
VI ...	Parks	Roads	4,000	...	Mr. G. F. de Montmorency, I.C.S., officer on special duty with the Government of India.
		Irrigation channels	1,32,000	...	
		Housing establishment and cattle ...	9,000	...	
		Levelling ground, drainage, grass, trees and gardens.	6,60,000	...	
		Special work cha ge establishment ...	33,000		
				8,38,000	
VII ...	Buildings	Residences for officials including Government House.	102,26,152	...	Captain W. H. Roberts, R.E., engineer officer on special duty with the Government of India.
		European clerks' quarters	25,58,708	...	
		Indian clerks' quarters	43,44,012	...	
		Secretariat and other office buildings ...	86,03,030	...	
		Miscellaneous public buildings	4,89,000	...	
		Menials' quarters	2,69,340	...	
				264,90,242	

VIII ...	Lighting	Installation in rentable buildings ...	8,27,918	...	Captain W. H. Roberts, R.E., engineer officer on special duty with the Government of India.
		Government House	18,200	...	
		Secretariat and other office buildings ...	4,45,780	...	
		Street lighting (exclusive of mains) ...	2,04,551	...	
		Distribution mains	1,80,000	...	
		Generating station	13,40,000	...	
				30,16,449*	
		Total of direct outlay on works ...	...	4,35,28,082	
IX ...	Establishment ...	......	60,59,573	60,59,573	Captain W. H. Roberts, R.E., engineer officer on special duty with the Government of India.
X ...	Tools and plant ...	......	6,00,000	6,00,000	In round lakhs 1½ per cent on works less land.
		Grand total Rs. ...		5,01,87,655	

* At the time of going to Press Mr. Pitkeathly has totalled his estimate; it is nearly Rs. 4,3 00,000.

Estimates have not been prepared for furniture as this can be more readily made in the Government of India Public Works Department secretariat who know the stock which will be taken over from Temporary Delhi.

It should be noticed that this estimate contains no provision for city and river improvements, the afforestation of the Ridge, levelling off of mounds, or the filling up of low places, the provision of race courses and play grounds; and only a modest sum under miscellaneous public buildings has been provided for medical and other schools, civil and veterinary hospitals, markets, dairies, cemeteries, slaughter houses, cathedral and other churches. The estimates have been taken out from the best information available, and the quantities being of a lump sum character no extra money has been added to the lump sum at first suggested or proposed to cover other contingencies not disclosed. The levelling off of the site is one on which any amount of money can be spent, and it has been assumed that no more of this work will be done than can be got from the money allowed for buildings, parks, roads, storm water drains, sewers, etc. Spoil will be produced at some places and borrows needed at others, and it is assumed that the engineers will utilise these to improve and not to disfigure the site. It is assumed that the rates for labour and material will not be higher during the time of construction than they are now.

Each estimate will now be dealt with in the order given in the above statement. It is thought that it will help the mind to more readily grasp the problems involved if the estimates based on maps and sections are first explained leaving the buildings to the last.

LAND.

Estimate No. 1.

3. This estimate has been prepared by Major Beadon and only the information needed to explain what sum it is proposed to debit to the New Capital is extracted into estimate No. 1. The acquisition of land is in hand, and action is in advance of that dealt with in this report, and this may enable more up to date figures to be inserted. The sum charged in this estimate provides for the acquisition of the land, homesteads and the redemption of assignments on Blocks B. and E. only, and the forecast provides for the expenditure of the whole sum before the end of the current financial year. Block B. is the site selected for the New Capital, and Block E. is the foreshore of the river that contains the sites proposed for race course, sewage farms, and future development of the capital, and are shown on the maps that accompany Major Beadon's report.

STORM WATER DRAINS, SEWERS AND SANITARY INSTALLATION.

Description of area to be drained.

4. To the health and comfort of a modern city, drainage is of first class importance, and the lay out will be designned to take full advantage of the unusual facilities for good drainage that the site affords; it is seldom that the site of a town on the plains has so good a slope as is given by this situation on the skirt of the rocky ridge, which itself is comparatively close to the river, so that the declivity of the nalas is everywhere good; though seldom sufficient to provide self-flushing velocities in sewers that deal with the small volumes obtainable from the garden city part of the lay out. The marked features are displayed in the plans Nos. XII and XIII in which water partings are depicted in various colours, and the beds of the nalas in blue, while the contours at five feet intervals shew clearly the declivity of the ground; while plan No. I shows in appropriate colours the allocation of building sites into suburbs, that has been submitted for the criticism of the departments of the Government of India, and is at the time of writing still in circulation. These maps show that the site coincides very approximately with the complete drainage basin of two systems of nalas that converge near the Khera belonging to the village of Babarpur, and that drain the vicinities of Paharganj and Khushak, and in these reports are known by these names. The Khushak is the upper reach of the Shakar-kui nala that outfalls through the Barapula into the river below Kilokri.

The method of indexing the nalas is explained in paragraph 3 of the report on storm water drains. The water parting between the above two systems is shown by a green line, and that of the whole basin by a vermilion one. The junction at Babarpur village is only a mile from the high bank, and a mile and a half from the main stream of the river; the outfall cut direct to the river would be through the ruins, or Khandrat, of a former city, but could to some extent be cheapened by following depressions, perhaps ancient streets or may be artificial drains. The saving of distance over that in the tortuous natural nala that outfalls below Kilokhri is about two miles, and an outfall for both sewage and storm water on the alignment is worthy of detailed investigation.

For estimate purposes a system of sewers on the separate system has been schemed to follow the natural drainage lines as much as is permitted by the roads proposed in the latest lay out suggested by Mr. Lanchester before leaving for home. This has been arbitrarily chosen as the lay out where it was necessary to have one in order to obtain figures for the preliminary estimates.

Drains to carry storm water only have been designed to follow the natural nalas, the profiles of sewers and drains given in plans Nos. VIII to X and Nos. XV to XVIII respectively will still further help to realise the lie of the ground and its capabilities for providing a comfortable and healthy town.

The main outfall and the river.

5. The proximity of a river, which, in the first week of July, only had about 60 cusecs and with only a moderate flood, some two and three quarters feet below the maximum, carried one and a quarter lakhs of cubic feet, will make the sanitary engineers anxious about the outfall. The information in the canal offices is very complete and indicates that the sewers and drains should be kept as high as possible but not so unduly high as to make it necessary to omit from the lay out any very desirable tract; though low-lying areas, such as worked out pits of ancient brick-fields, of which there are many near the outfall, should not be built on without detail investigation of their level, relative to the flood line in the drain when the river is in flood and heavy rain falling, a coincidence that has occurred seven times since 1900 and must, therefore, be reckoned with in detailed town planning. The salient points to do with the foreshore and the outfall into the river have been dealt with in some detail in the report to the estimate of storm water drains No. II (*a*), to enable instructions to be given to what extent river improvement should be included in the project for the Capital City. This is a project on which any amount of money could be spent; but its value to a young city likely to be fully occupied for many years in developing its gardens, roads and parks not to mention its public buildings, needs to be closely connected to health, comfort, and convenience to justify expenditure. Thus far the investigations have not disclosed any such close connection, and no money has been put into the estimates for river improvements, except that a small sum for the road along the river edge has been included in the road estimate because this is one of the roads on the plan.

The means by which quantities have been obtained for the estimates.

6. With this description of the possibilities of the site for drainage the estimate for storm water and sewers Nos I (*a*) and I (*b*) may be explained. For each estimate, channels and conduits respectively have been aligned, graded and the sizes calculated and suitable designs made and estimated. The size of the main outfall drain for storm water is a channel 100 feet wide and 7 feet deep having a velocity of nearly 9 feet a second at full flood. The larger branches are 50 feet wide and 7 feet deep, but rapidly decrease to about 5 feet in width and 4 feet deep; the velocities allowed seldom reach 10 feet a second, whereas it is believed that with the weight of material provided, the Delhi quartzite could withstand a maximum velocity of 20 feet a second, seeing that much over 10 feet a second would not occur many times in a year and then only for a few hours on each occasion, while the sizes allow for a rainfall run off of one inch an hour,* which should be sufficient on a comparatively large catchment in a garden city. The amount provided for tributary drains should, therefore, suffice. The main outfall drain is a large work and the

* Discussion with Captain Kealy, R.E., about the nalas in the Cantonment area has directed attention to the feasibility of largely reducing the volume to be dealt with by the nalas by terracing in some suitable way the catchment on the rocky ridge thereby also aiding the growth of trees and adding to the subsoil flow. The effect of the existing dams in reducing the size of nalas is evident on the map and can be studied on the ground.

estimate for this might easily be very much out, but the information provided on the plans is very complete and any errors of optimism should be readily detected. The sewers are usually of minimum section and much larger than really required while the size required at the main outfall to deal with 8 per cent of the daily water supply (10,00,000 gallons) in an hour could easily be dealt with by an 18 inch stone-ware pipe, whilst a 24 inch brick sewer is estimated for. Difficult items to estimate for are flushing and ventilation, and the extent to which branch sewers will be required to accomodate compounds. The latter depends on the extent to which water closets are introduced into bungalows, a matter that the expert sanitary engineer and architect should deal with at once as the design of bungalows with water closets and bath rooms connected to drains is likely to be radically different to the usual arrangement on the plains.

The sewage farm is proposed below Purana Kila, this is the only feasible site that has suggested itself, ample land of a proper quality is available on the foreshore; though this is a point that needs verification by trial pits that will be made as soon as the revised estimate for establishment, submitted in August is received back sanctioned with respect to this item.

The Khandrat and park area about Safdar Jang.

7. Some part of the area selected is outside the area that drains naturally to the outfall at Purana Kila, notably the tract called Khandrat, very broken ground lying between the Okhla navigation cut and the high bank of the river, and extending up to the city wall towards the Ajmir Gate; this area will be readily drained direct to the river or to the existing city drains. In detail much intricate designing will be required, but the expense should not be great.

The Pilanji nala drains the park area around Safdar Jang, and it is probable that little or no expenditure will be required here until sometime after the capital has been established.

The sewage farm of present Delhi.

8. The sewage of the city of Delhi outfalls to a farm below Feroz Shah Kotla. The town planning experts were hopeful that this outfall could be transferred to the proposed farm below the Purana Kila, but the Honourable Mr. Goument, Chief Engineer, United Provinces Government, who knows Delhi well, considered that on account of distance, levels, and cost and the fact that the site is admirably suited to a sullage farm for the old city, it should be retained. In the absence of Mr. Salkeld, Municipal Engineer of Delhi, on leave in England, it would be a waste of time, not spareable, to investigate the levels, and thereby the cost of the proposals, but Mr. Salkeld will soon be back, and any investigations that suggest themselves can be carried out provided the small establishment allowed is not otherwise commanded. No money has been put into the estimate for remodelling the sewage farm of existing Delhi.

The estimates.

9. The estimates for storm water drains and sewers are as follows :—

			Rs.	Rs.
STORM WATER DRAINS.				
Main outfall drdin.				
Excavation and lining channel	...	...	3,64,773	...
Provision for bridging channel	...	...	35,227	4,00,000
Tributary drains.				
Excavation and lining channels	...	...	8,94,118	...
Clearing out the Pilanji drain, draining the Khandrat and branches to connect to roads and compounds	...	...	2,05,882	11,00,000
Carried over		...	...	15,00,000

		Rs.	Rs.
Brought forward	...		15,00,000
Sewers			
Sewers ...	... ...	5,25 000	...
Manholes ...	... ...	63,000	...
Other small works	... ...	32,000	...
Ventilators ...	... ...	50,000	...
Flushing ...	... ...	1,00,000	...
Sewage farm	... ...	30 000	...
Unforeseen ...	... ...	55 000	...
			8,55,000
Total	...	...	23,55,000

The conveniences to be got by using watersheds as roads.

10. The provision for bridging main outfall drains is for existing roads, not new ones—these are estimated for under roads. Flushing and ventilation are likely to be expensive items, but in the combined estimate the sum total should suffice to make a comfortable and healthy town especially if the lay out is made with due regard to the lie of the ground; for instance the watersheds suggest themselves as suitable for the alignment of main roads that would have nice grades for the road surface and present good drainage gradients for themselves and the bungalows along them. Culverts too would be much reduced in number and in cost. In fact the difference between the cost of a lay out made regardless of drainage and one that is subservient to drainage is not only great in first cost but in upkeep; all problems to do with the engineering of the site solve themselves naturally, the natural curves on the roads should also commend themselves to the aesthetic.

Sanitary installation.

11. Mr. Parker has gone very carefully into the cost of an installation for collection and destruction of household refuse, providing latrines, watering streets, and for providing washing places. The figures brought together are instructive, but the estimate, given on the margin, has only been prepared to raise the question whether an installation of this kind is a fair charge to the New Capital and whether it would not suffice to add the cost of public latrines to the estimate for sewers raising the sum under drainage to Rs. 24,55,000, the other articles being found by the enclave when it takes over the city.

		Rs.
Dry rubbish carts	... ...	3,75,000
Incinerators	... ...	1,00,000
Latrines	... ...	1,00,000
Water carts	... ...	37,000
Urinals	... ...	18,000
Washing places	... ...	
Dhobi ghats	... ...	
Total	...	6,30,000

IRRIGATION.

Introductory remarks.

12. A garden city in the climate of Delhi is dependent on an irrigation water-supply completely under control for the handsomeness of its arboricultural and horticultural effects; furthermore the expense of growing trees and shrubs—other than the outlay on irrigation water is so large that the saving between a reliable and unreliable irrigation installation is likely to be wiped out should the plants become stunted in appearance due to climatic calamities that the irrigation was installed to avert; for this reason earnest attention has, from the initiation of the investigations preliminary to building the new capital, been given to the best means of securing a reliable, as well as an economical, irrigation supply and many alternatives have been investigated and thought over; as early as the 7th January His Honour, Sir Louis Dane, had detailed engineers to this investigation.

Supply in the river.

13. As is well known the waters of the river Jumna are fully utilised by the canals and towns on its banks, but there can be no doubt that the Capital City has a claim to take from the river as much water as is reasonably required.

The water that passes Delhi would otherwise enter the Agra Canal of the United Provinces where the full supply discharge is some 2,000 cusecs, but its minimum supply, unless supplemented from the Ganges through the Hindun River, falls to the discharge passing Delhi, up to this year thought to be between 100 and 200 cusecs, but early in July just before the rains broke a little over 60 cusecs were gauged by the engineers of both canals, or about twice what would be required to satisfy the demands of the New Capital for irrigation and drinking water at such a season. The year was unusual in that the rains so far failed over the catchment of the Jumna that from April 1911 to July 1912 the river supply seldom exceeded the needs of the two canals taking out at Tajawala at the foot of the Siwaliks, and the flow at Delhi was seldom other than the water that springs up in the bed of the river below the off take of the western and eastern canals. Such a year was last experienced in 1877; at that time the demands for irrigation were much less and the country on either bank of the river above Delhi was over irrigated and much afflicted by swamps that doubtless fed the river by sub soil flow. Quite what will be done when a similar drought recurs is difficult to foresee, the two canals at Tajawala could ill spare the water to make good a deficiency that involved the stoppage of irrigation. The actual volume required would be small, but the wastage on the way from the nearest channel in flow at the time to Delhi would be very great. There is every hope that the Sarda Ganges Jumna Feeder scheme will be in flow before such a year recurs, and in that case there will be no difficulty in replenishing the Jumna; as the Ganges and the Sarda will not suffer in the same year that the Jumna does, and in any case they have much better minimum flows.

The subsoil flow.

14. The subsoil flow cannot be relied on because it too falls rapidly in dry years owing to the proximity of the ridge limiting the catchment area of the ground water; the proof of this is in the great depth to which wells have been taken in times of drought, when necessity has compelled the people to sink as the springs dried down; in times of drought when the demand is keenest the subsoil supply may fail, and resort must be had to the river or the canal, the latter will only be able to supply water by rotational turn, and it seems better, therefore, to place the pumping station on the river to get the benefit of any water from the subsoil, and from the outflow through the sewers of the waste water of the drinking and of the canal supply, if by good luck there be any to spare.

Reasons for adhering to the pumping scheme.

15. For this reason the estimates prepared at the request of His Excellency the Viceroy, in March last for the cost of a supply pumped from the river are put forward as the best and most satisfactory way of dealing with the irrigation that has so far presented itself.

The canal supply.

16. Before going on to deal with the estimates it may be noticed that the information about the working of the canal at Delhi, as revealed by statistics, has been carefully collated, and shews that in times of good rainfall the closures due to lack of demand are very long indeed, nearly 2 months, in fact, this is the storage period that the railway engineers provide in their canal filled tanks at Karnal and Sonepat. Ornamental gardens and parks cannot go so long without water as the staple crops of the vicinity. At the Durbar the demand for water for their gardens by the camps was keen within a few days of the cyclonic fall of about ten inches that fell about the 28th September when the sun had already lost much of its power. So that although the canal is closed in times of keen demand by rotational turn for periods of from 10 to 15 days, the closures due to good rainfall are likely to be quite as ruinous to high class horticultural and aboricultural work. The use of canal water, therefore, necessitates storage of some sort, and no satisfactory scheme for this, such as can be recommended, has been hit upon; nor is it possible to so remodel the canal as to provide a constant flow at Delhi. The efficiency of a modern canal depends on the rotational system of working which enables the farmer to get

his water at convenient intervals, and enables him to then devote himself to his ploughing or tillage; besides the first cost of such a remodelling will be the indirect charge due to loss of prosperity to the country side as well as revenue to the canal. Moreover the canal from its head downwards could never be closed for repairs, or only for very short intervals, and then at the risk of bringing down wrath and damaging criticism difficult to meet from very influential quarters. No one who has the interest of the toiling husbandman at heart would knowingly place the source of his prosperity under so stringent a servitude even though several lakhs of rupees could thereby be saved in the first cost and future working of the Imperial Capital.

Possibilities that economies in working expenses may be arranged for in designing the lay out.

17. As already said no such saving appears securable even at the risk of damaging the interests of the irrigators of the canal and the luxuriant growth of the trees and shrubs of the new capital. It may however be possible in designing the city to take advantage of such resources as there are in the river, canal and subsoil, and to combine them into a whole, such as will make the annual cost of growing green things less. For instance bazars that require only a limited irrigation supply may be placed on higher ground, off which incidentally the drainage is also likely to be more economical, and in consequence the health of the community better. If the parks in the Khandrat area are planted with trees and shrubs that can go without water when the canal is closed, or if storage can be arranged for the more delicate in an economical way, the annual cost of irrigation will be cheapened to that extent; but the first outlay, and this estimate only deals with initial cost, is likely to be just as heavy as for a pipe supply; the ducts must be lined in the interests of health and comfort; the reckless flooding of the subsoil to the detriment of the amenities of the vicinity, that is inseparable from earthern channels supplied by a canal must be made impossible in a city of the importance to the Empire that Delhi has now become. It is not necessary to digress and give an essay on the lowering of vitality and physical energy that accompanies a saturated soil and moist chilly atmosphere, nor on the impossibility of obtaining really fine gardening effects in such an environment. These remarks may be closed by noticing that although the detail to be worked out is still great the problem to be tackled has been carefully thought out and clearly presented by Mr. Sopwith and the sum total given by him should be ear marked as needed for irrigation.

Filtered and unfiltered supply.

18. No serious opposition has so far been felt to exist to an unfiltered irrigation supply, the comparative estimating required to ascertain whether a combined drinking and irrigation supply could be economically installed is a long and elaborate task because the recurring expenditure must be very carefully diagnosed and estimated, and this involves the careful scrutiny of a large mass of statistics as well as of calculations, and such a combination is not likely to receive strong support unless it can be carried out for less cost than the sum set down in this estimate. The comparative estimates are in hand but they come really more within the scope of the engineers to be charged with preparing a project than with the special staff of the experts.

The measurements on which the estimates are based. Location of installations.

19. The estimates provide for a supply pumped through double 33 inch mains from the river Jumna at the sewage out fall, assumed to be at Purana Kila, to two conveniently placed reservoirs on the lower part of the ridge at R. L. 750, one near Malcha and the other near Kalali Bagh, the mains bifurcating near the centre of the lay out close to Raisina; the area to be served being divided into two equivalent tracts by a line through Purana Kila and Tal Katora; for estimating purposes the distribution system of the southern tract has been worked out. It is found that economy in recurring charges is obtained by placing the floor of the reservoir at as low a level as is consistent with the efficient command of the plots to be irrigated. No provision has, therefore, been made for irrigating the canton-

ment or the ridge as these involve lifting the water to a much higher level, and can best be dealt with in the estimates for the cantonments and for the afforestation of the ridge respectively.

Area protected.

20. The area protected by the skeleton scheme drawn out and estimated is 12 square miles of parks, roads and compounds. Some reduction of cost could of course be obtained by reducing this area, but things are not advanced enough towards a definite lay out to admit of putting forward figures based on a less area.

Duty.

21. The accepted duty for irrigating gardens and lawns by a piped supply is—

Gardens	...	44,000 gallons per acre per week, or ·0016 cusecs.
Lawns ...	...	22,000 gallons per acre per week, or ·0058 cusecs.

These are equivalent to two and one inch of water a week respectively; the duty for road watering may be taken the same as that for lawns.

It has been calculated that in each acre of the gross lay out there will be one eighth of an acre of garden, and a like area of roads and of lawns so that the supply needed to protect an acre of lay out is ·0029 cusec arrived at as follows:—

1/8 acre of gardens at	·0116	cusec per acre	...	...	·00145	cusec.
1/8 acre of lawns at	·0058	ditto	...	...	·000725	„
1/8 acre of roads at	·0058	ditto	...	...	·000725	„
			Total	...	·0029	cusec.

Discharge required.

22. That is the area will be protected if ·0029 cusec per acre is allowed on the whole area or $22\frac{1}{4}$ cusecs for 12 square miles; it has seemed advisable, therefore, to get out the estimate on a round 25 cusecs especially as the sewers are likely to require much flushing.

Economy resulting from continuous day and night supply.

23. The estimate shews that Rs. 7,46,677 can be saved in original outlay if the irrigation is arranged to go on throughout the 24 hours as is usual on all canal systems, and this economy has been made and the estimate reduced from Rs. 49,01,564, the cost of a daylight supply, to Rs. 41,54,887, that of the day and night service; the gardeners will have their daylight supply turn and turn about; this custom once established should work alright and may even be popular.

The reservoirs.

24. The reservoirs provide a 12 hours supply; seeing the facilities that the ridge offers for this luxury and convenience this is a modest start that future decades may enlarge on.

Pumps.

25. The static head is 105 feet, and total pumping head 125 feet, and the pumps should be of 444 horse-power and will probably require to work for 300 days in the year, and if so the energy consumed will be 32,04,800 horse power hours.

Outlay by main heads.

26. The main heads of the estimate for a 24 hours supply are as follows:—

					Rs.
Pumps for 444 horse-power at Rs. 975 per horse power				...	4,32,900
Reservoirs, ten feet deep		...	...	...	65,680
Rising main	...	...	...	...	15,59,480
Distribution and service pipes		...	...	...	15,69,110
Valves, etc.	...	...	...	...	1,50,000
Contingencies	...	...	...	...	3,77,717
			Total	...	41,54,887

27. The cost of service pipes serving bungalows and all areas except public parks is not provided, as this is a charge against the bungalow estimates, being included in the plinth area rate.

Cost of service pipes to residences.

28. Points needing instructions, the programme of work and the rates will be dealt with in the conclusion of the report for all estimates together.

Points needing instructions, programme of work and rates.

DRINKING WATER SUPPLY.

29. The estimate is concerned only with the domestic supply of the New Capital proper, but, since the domestic water supply for the cantonment, and also for the extensions of the existing city may also be drawn from the same source, the engines and mains have been designed to deal with the domestic supply required for all sections, later on in this note certain points in this connection will be dealt with.

Scope of estimate no. IV.

30. Water for roads, for fire protection, for flushing and outside latrines has not been allowed for, as water supplied for irrigation can be used for these purposes. In this connection it may be noted that the pressure in the irrigation distribution pipes, as designed, is not sufficient for fire protection by direct connection by hose, though the supply is ample for fire engines to pump from the nearest stand posts. The drinking water supply in case of emergency could undoubtedly be used in addition, as the service reservoir, with additional pumping, would balance any abnormal supply taken in emergency.

The division of the services between irrigation and drinking water supplies.

31. Water for afforesting the ridge is also not allowed for, although the greater portion of the ridge is not commanded by the irrigation supply, yet a small subsidiary pumping plant could easily deliver water from the irrigation service reservoirs for this purpose, and the drinking water supply, in times of small demand, such as when the Government of India are not residing in Delhi during the hot weather might also be used, as the reservoir is high enough to command the whole ridge.

Water for afforesting the ridge.

32. The position of the intake works are proposed near Chandrawal, the site of the present Delhi water works, but Mr. Parker suggests that other sites should be considered. The water, must of necessity, be withdrawn from the river upstream of Delhi for sanitary reasons, but Mr. Parker points out that the Chandrawal site has the disadvantage of possible pollution owing to the villages of Chandrawal and Wazirabad being upstream of it, as well as the outfall of the Najafgarh Jhil drain.

Site of intake, and conditions affecting the purity of its supply.

33. The site that he suggests as a better one is at Wazirabad, where the river rounds the rocky ridge. This, he points out, would remove the fear of pollution from the villages of Chandrawal and Wazirabad, though the site is still downstream of the outfall of the Najafgarh Jhil drain. To remedy this he suggests that the drain should be diverted so as to run through the low reach of land south west of and close to the Wazirabad mosque just south of the village and so outfall downstream of the works.

The Wazirabad site.

34. Old plans of* the drain in possession of the Western Jumna Canal show that this low reach was in fact formerly traversed by the drain, but this line was abandoned in favour of its present course. This may have been due to the phenomenon that large drainages tend to discharge their waters more or less against the main stream, and, if carried more or less in the direction of the main stream they silt up at the outfall. This suggestion, therefore, needs further investigation from an engineering point of view

Remodelling the Najafgarh drain outfall.

*Also see plate 7 page 32 of Baker's memorandum on the Western Jumna canals published in 1849 which shows that at that time the outfall of the drain was as at present, and the passage past the mosque was a mill race.

Sources of pollution of the drain.

35. The sources of pollution of the drain are due to the fact that it carries off the accumulation of storm water from a large tract with its centre in the Najafgarh Jhil some 16 miles west of Delhi, and the drainage of the many villages in this tract is all carried in the water, amongst which is that of the not very clean suburb of Sabzimandi, furthermore the cavalry lines and the present temporary accommodation for the hosts of clerks, who will inhabit the temporary works are situated on ground that slopes down to this drain. The latter source of contamination will not necessarily disappear when the new Capital is completed, and the other sources must always remain. In addition the water of the Western Jumna Canal is occasionally escaped into the drain, and analysis has shown that this water is very impure. It should be noted that, although the flood in the drain is large when heavy rainfall has occurred being up to 200 cusecs, yet during a large portion of the year the discharge of the drain is very small indeed. The risk of pollution, if the supply is from this source, is, therefore, one that requires careful examination by the sanitary officers. It may be noticed that, if a new site is selected and the works are not combined with the existing works, a completely new establishment will be required, and the expense increased by this as well as by new training works etc.

Positions of mains and of service reservoirs.

36. From the intake works it is proposed to pump the water in as straight a line as possible to the Qadamsharif on the present Kutab road, where the supply for the indian city extensions will be drawn off; thence in a south westerly direction along one of the new capital roads until near Talkatora, where the pipe line will bend in a westerly direction to the site of the service reservoir, which is at the highest point of the ridge marked B. M. 865·5.

Engineering details.

37. The engineering details of this supply having been fully discussed by Mr. Parker will not be recapitulated; the various alternative methods, in which some of the items can be treated, and which require decision, are also fully explained, and have been catalogued by him in the list of points requiring decision before the final project can be prepared.

Quantity of water required.

38. The quantities of water required are

for the New Capital proper, 1,000,000 gallons per day.

for the Cantonments, 250,000 gallons per day.

for the Indian city extensions, 75,000 gallons per day.

These figures have been arrived at as follows:—

(*a*) The daily allowance for Europeans has been taken as 30 gallons, and for Indians as 15 gallons. These quantities are based on the quantities given in Parke's "Practical Hygiene." The allowance for Indians is only exceeded by two towns in the Punjab and United Provinces which have a piped water supply, *viz*, Cawnpore and Lucknow, where the average daily consumptions in gallons per head are 18·43 and 19·54 respectively. In the former town the number of mills and factories accounts for the excess, and in the latter, the number of pilgrims, forming a floating population not included in the permanent population, probably accounts for the large quantity.

The average of all towns is 11 gallons per head per day, so that 15 gallons is ample and will ensure that no water need be taken from impure sources such as wells.

(*b*) The population of the New Capital proper has been taken as 5,000 Europeans and 40,000 Indians. These figures have been arrived at by taking the number of residences, etc., given in the schedule of areas and allowing for the probable population of Europeans and Indians respectively in each residence.

In addition certain buildings such as Government House, secretariats and other offices, hospitals, dairies, conservancy, markets, shops, schools, clubs etc., have to be supplied with water, and assumed amounts have been allowed. For Government House an allowance of 25,000 gallons per day has been provided,

being over 25 per cent more than the daily consumption at Viceregal Lodge in Simla, as more water will be required in Delhi than Simla. The secretariats have been allowed 25,000 gallons per day, and other reasonable quantities have been assumed for the other buildings, and are fully set out in Appendix B., of the estimate no. IV.

(*c*) The cantonment supply is based on figures given by the military authorities who calculated a population of 6,000 persons and 2,000 horses, with a through allowance of 30 gallons per head per day.

It is probable that this supply will not prove sufficient,* and that modifications will have to be made, if revised figures, as is probable, are later cn, given by the military authorities ; these if unaccompanied by counterbalancing revisions in the needs of the other shareholders will bring about alteration of the estimate, but it is unlikely that any large difference will arise from this source.

*Since the completion of this note a request has been received from the military authorities to take a figure of 5,00,000 gallons per day instead of 2,50,000, and even this may not be a final one.

(*d*) The supply for the Indian city extensions is based on a probable population, including the press settlement (12,000 individuals), of 50,000, with a through allowance of 15 gallons per head per day.

Gross total to be pumped.

31. The total supply required to be delivered is, therefore, 2,000,000 gallons per day, and this involves a daily pumping of unfiltered water of 2,445,417 gallons, the balance being to allow for loss by evaporation in the filter beds and settling tanks and also for loss by wastage in the cleaning out of filter beds.

Number of hours of pumping per day.

40. It is proposed to pump this supply in 16 hours, so as to allow of the engines being at rest for 1/3rd of the day, and to enable the establishment to be organised in two shifts, thus causing economy in establishment charges. The distribution within the areas is proposed to be such that one half the total daily supply can be drawn off in six hours. This is in accordance with experience on water works which goes to show that the main demand occurs in the morning and the evening. The provision of a service reservior allows for this distribution by balancing and obviates the necessity for pumping at this rate which would add largely to the cost. The points connected with the site of the service reservoirs, and distribution within the New Capital, the methods and rate of filtration, the system of settling tanks to be adopted, the types of engines, the sizes of mains etc. are engineering ones, and as has already been said have been fully dealt with in the report of the estimate.

Telephone system.

41. A Telephone service is needed to ensure prompt action in the case of damage occurring on an important part of the system or in an emergency such as a fire. The rent for this has been capitalized and is Rs. 14,000 only, this sum will not really be paid and the estimate might have been reduced by it so far as concerns this reference.

Estimated cost, and source of prices etc. used.

42. The estimated cost of the project is Rs. 19,82,380/- and this is divided up for ready reference under the following heads :—

	Rs.
(*a*) River training works	1,00,000
(*b*) Intake	40,000
(*c*) Suction well	8,000
(*d*) Settling tanks	86,000
(*e*) Filter beds, sand washer, sand washer machinery ...	93,500
(*f*) Clear water reservoirs	35,000
(*g*) Engines and pumps including all buildings ...	4,16,400
(*h*) Service reservoir	62,500
(*i*) Pipes valves, meters etc.	11,01,320
(*j*) Telephone service	14,160
(*k*) Roads	10,000
(*l*) Fencing	3,500
(*m*) Preliminary expenses	12,000
Grand total (*vide* estimate no. IV) ...	19,82,380

The prices used for the various items in the estimate, and the percentages taken for engines etc. are based partly on an old estimate for the Benares water works and partly on figures obtained from the Hon'ble Mr. Goument, Chief Engineer, to the Government of the United Provinces, whose ever ready and generous help whenever asked for should be gratefully acknowledged in the reports on roads and lighting and as well as here.

Division of charges among the three share-holders.

43. As explained in paragraph 29 of this report the engines and mains have been designed to deliver the requirements not only of the New Capital proper, but also those of the cantonments and of the Indian city extensions. The proportionate share of each has been arrived at as follows:—

The requirements of the New Capital proper, the cantonment and the Indian city extensions are in the proportion of 4 to 1 to 3, therefore the charges common to all three have been divided in this proportion. Those charges which are common only to the first two have been divided in the proportion of their requirements, *viz.*, 4 to 1.

The sums thus arrived at are :—

	Rs.
New Capital	13,56,044
Cantonments	2,00,851
Indian city extensions	4,25,485
Total	19,82,380

It may be noted that this estimate only deals with distribution within the new capital proper, and that the distribution systems of the cantonments and of the Indian city extensions are not included in the cost, the above figures merely respresenting the respective shares of charges connected with the engines and mains.

Possible extension of existing water supply to new areas.

44. Mr. Parker in his report has raised the question of the possibilities of the existing water supply of Delhi.

On a 16 hours pumping basis he shows that the maximum existing capacity of the unfiltered water engines is, 2, 560,000 gallons per day of 16 hours whilst the filtered water engines can deliver the 5,000, 000 gallons. The capacity of the installations is governed by that of the weaker plant; the stronger plant having surplus power idling.

The population of Delhi according to the 1911 census returns is 2,32,837, so that the maximum capacity on a 16 hours pumping basis, gives a supply of about 11 gallons per head per day, as against the allowance of 15 gallons which is being made for the new works. From this Mr. Parker argues that the existing water works of Delhi should be utilised for the existing city, and that there appears to be no possibilities for their use by extension to the new areas.

A considerable increase in the maximum capacity of the existing works is however in course of being made by the Municipality of Delhi, and assuming that it will eventually introduce additional engines, a supply of 4, 500,000 gallons per day could be given, the filter beds etc., which have recently been constructed, being sufficient to deal with this rate of supply. If such a supply was given, it would raise the available supply to over 20 gallons per day per head of the existing populations. It would not, therefore, seem to be outside the region of discussion whether the existing water works might not be extended to serve part of the new areas.

As the service reservoir of the existing system is some 80 feet lower than the proposed service reservoir of the New Capital, only a small portion of the New Capital proper could be served by extension, and for similar reasons the cantonments are also outside discussion.

45. But it would seem possible that to serve the Indian city extensions by extending the existing works might be a more satisfactory arrangment than to serve them from the combined system proposed by Mr. Parker. The extensions will not have a population of 50,000 from the start, and its development may not be very rapid.

The possibility of supplying the Indian city extensions from municipal water works.

The normal increase in population of Delhi is some 20,000 per decade, and assuming that the population will increase at a greater rate now that Delhi has become the Capital, (say 25,000 per decade) it will be seen that nearly 20 years will elapse before the estimated population of 50,000 is reached.

To incur increased capital outlay in laying down a plant to serve this full population of 50,000 does not appear to be warranted, and it might certainly be considered whether it would not be sufficient to leave the water supply arrangment of the Indian city extensions to the authorities, who will control the present water works system.

46. In this connection it should be noted that the existing service reservoir could supply water at a level of R. L. 760, which is higher than the greater portion of the extensions area, if such a system were adopted, the capital outlay given in this estimate would be decreased, though not proportionally. The shares of the New Capital proper and the cantonments would also vary from the figures given, that as it is more than probable that the cantonments will take a much greater quantity of water than they at present ask for the total capital outlay is not likely to be much if any below the present estimate.

The effect of the above proposal on the estimates.

47. These will be dealt with as remarked in paragraph 28 on the estimate for irrigation at the conclusion of this report.

Points needing instructions, programme of work and rates.

ROADS.

48. The Delhi Town Planning Committee before leaving for England had designed a tentative lay out of roads; Mr. H. V. Lanchester, who arrived in India about the time the Committee were returning to England, submitted in turn as his labours progressed a design for a lay out, then a revised design, and finally on the eve of his departure, a third, known now, as his "second revised lay out of the 30th July 1912." This is the one used in all these estimates (except that for irrigation) as it was under discussion at the time that the work of drawing preparatory to estimating was started in earnest. It need hardly be remarked that the estimating would have flowed on for ever unless a period was put for the time being to the collection of facts, and the consideration of alternatives, a complete picture of the proposals in the field at some particular moment was a desideratum; without this the pile of files was valueless, having no key by which to open them.

Lay out used in estimate no. V.

49. To revert to our subject, the lay out can best be understood by referring to plan no. 11 on which the roads have been coloured up, distinctive colours representing roads of different widths, these widths are not true to scale on the map being made wider than their dimensions, to shew them up. Mr. Lanchester gave in addition to the widths, the proposed gradients of the roads and also furnished type cross sections. It was, therefore, possible to base an estimate on these details, but as Mr. Lanchester did not give the weight of metal to be used, this part of the estimate is based on the specification supplied by the Committee in the type designs, which were left by them for the main avenue from Government House to the Jumma Musjid.

Estimated cost of the roads proposed by Mr. Lanchester.

The roads thus estimated will cost Rs. 31,86,380, (*vide* statement M of estimate no. V.) This total includes culverts, footpaths, grass, trees, riding paths and curbs.

50. It appeared, however, to indian experts that the widths of the roads with their wide berms (involving undue dust) and also the weight of the metal were too great, and so, for the purposes of comparison, an alternative estimate was made in which the roads were considerably reduced in width, as shown in statement N, of the estimate, and the metalling and paths arranged more in accordance with indian practice.

Estimate of cost of alternative design of roads.

The Committee advocated a soling coat of 10 inches and a metalling coat of 6 inches. The alternative estimates allow for the more usual indian practice of 6 inches of soling coat and $4\frac{1}{2}$ inches of metalling, except in the 80 feet class of roads, where 6 inches are required by the exigencies of the design.

The cost (*vide* statement N) is Rs. 24, 38, 105.

Comparative statement of cost of the two designs.

51. For convenience, the following statement has been made out to shew the comparative cost of the two designs.

Nature of work.		Cost in rupees.	
		Mr. Lanchester's proposed widths of roads and Committee's proposed weight of metal.	Proposed alternative widths of roads and weight of metal.
Type road including grass, trees, etc.	...	21,51,589	16,88,181
Extra excavation in earth and rock	...	3,44,403	2,27,007
Culverts	...	6,90,388	5,22,917
Total	...	31,86,380	24,38,105
Deduct	...	24,38,105	...
Saving over Mr. Lanchester's proposals	...	7,84,275	...

52. One item in this statement merits notice, *viz.*, the large cost of culverts. As will be seen from the longitudinal sections, plans XV to XVIII, the storm water drains will be, for the most part, broad and deep, and consequently culverts over them will be costly. The reason for the great expense is that the lay out used in the estimates has been made without much consideration for the natural drainage of the country, which plan No. XII accompanying the storm water drains estimate shows to be both large and numerous.

Reason for large cost of culverts.

Doubtless, now that the Committee are in England with more leisure to go into these details, the lay out, upon which they are busy, will take account of this point, and roads will be designed so as to avoid these natural drainages as far as is possible, and in that case there is likely to be a considerable saving in this item.

53. The total mileage of roads is 131·29 miles, and the acreage of roads with Mr. Lanchester's proposals is 1115·32 acres, with the alternative proposals it is 896·10. The former represents about $17\frac{1}{2}$ per cent of the total area, the latter about 14 per cent, in view of the amount of accommodation to be provided and the small sizes of the compounds, the total acreage does not seem excessive.

Mileage and acreage of roads and proportion borne by acreage to whole area.

54. The principal object in preparing this estimate is to give the Government of India some idea as to what sum should be reserved for an adequate programme of road construction to be carried

The question of the development of roads that should be contemplated in the initial outlay on the New Capital.

out. In the general lay out of the roads, especially the grassing and arboriculture, will depend the fine aspect, which the roads of the New Capital must bear, and this lay out the Committee may be depended upon to produce. Doubtless tree planting will at once be started so as to ensure the trees being planted in their correct positions, but the rest of the road, *e.g.*, the amount of metalling etc., is a matter for gradual development. This development must depend on the sum of money which can be allotted for roads. This estimate, based on a careful study of conditions, seems to show that, for a sum of something less than 24 lakhs of rupees, the New Capital, can, initially, be efficiently laid out with roads. It is not by any means essential that all roads should be developed to their final full necessities immediately, indeed, this would involve a locking up of capital, that appears to be unnecessary. Many roads can be left as grassy glades, other roads, such as those on the ridge, may not be constructed if the afforestation of the ridge is undertaken, until after a forest has arisen. The road along the Bela would probably not come within the scope of this estimate, as it would probably form a component part of a big river frontage scheme. All these considerations are matters for discussion and the question of rate of development and the direction which it should take, is a matter that requires instructions.

Omission of new roads in existing city and proposed extensions thereof.

55. It may be noted that no new roads in the existing indian city or in the proposed city extensions are included in this estimate.

Points needing instructions, programme of work and rates.

56. These will be dealt with at the conclusion of this report.

PARKS.

Reports on estimate no. VI.

57. Mr. de Montmorency's report contains many details, and being brief and to the point, merits perusal in itself, and no further remarks are really necessary but it may be convenient to extract the salient points, on which the estimate is based.

Mr. Griessen's figures for cost of creating the Macdonell Park.

58. Mr. Griessen, the Government Gardener at Agra, supplied details of the cost of the Macdonell Park. From the figures supplied the cost of creating 1,093 acres of park would be Rs. 18,60,286 but the accounts need a personal visit to Agra to unravel, and there has been no leisure for this digression.

The main heads of outlay.

59. Mr. deMontmorency has, therefore, collected other figures from works within his and our cognizance upon which to frame an estimate, each item of which may be briefly noticed.

(*a*) Fencing should not be needed except to a very limited extent in a garden city having no through roads from which animals can stray and a strong cantonment law to control the selfish and careless owners of pets.

(*b*) The roads provided for the amenities of the new capital will suffice for access to the park areas, and Rs. 4,000 on paths seems ample.

(*c*) For irrigation branch pipes will be required which are estimated for at Rs. 120 per acre actually irrigated, a figure obtained from the experience got on the Durbar irrigation, the cost of this item is Rs. 1,32,000.

(*d*) The housing of the european gardener has been allowed for in the buildings estimate. The housing of indian gardeners and of a few cattle, the provision of a few special tool and potting sheds is allowed for by Rs. 9,000.

(*e*) Levelling ground, drainage, putting down grass, trees and shrubs and occasional bits of intensive garden, as Mr. de Montmorency remarks this is a very flexible item, as any amount of money could be expended, if available.

Most of the levelling up will be done with earth excavated from the storm water drains and will form part of the storm water drainage estimate. The public gardens at Lyallpur, the extension of the Lahore gardens and the Rawalpindi park cost about Rs. 500 an acre; a provision of Rs. 600 should secure reasonable development; the sum total for this head being Rs. 6,00,000.

(*f*) Mr. de Montmorency advocates a strong establishment in the early stages as being financially sound, and 5 per cent. of the total cost will provide Rs. 33,000 for this.

60. The total cost is therefore:—

		Rs.
(*a*) Fencing	... ...	*Nil*
(*b*) Roads	... ...	4,000
(*c*) Irrigation channels	... ...	1,32,000
(*d*) Housing cattle and establishment	... ...	9,000
(*e*) Levelling ground etc.	... ...	6,00,000
(*f*) Establishment during construction	... ...	33,000
Total	...	8,38,000

This amount is exclusive of land which is dealt with under another estimate.

The proposed outlay works out at about Rs. 766 per acre.

Points needing instructions, programme of works and rates.

61. These are dealt with at the conclusion of this report.

BUILDINGS.

The extent to which the data for estimate no. VII are still incomplete

62. As Captain Roberts' remarks, the data, on which the estimate is based, is not yet complete, as there are naturally in so big a question as this some departments, who cannot give their final requirements at Delhi, location of certain of the offices being still under discussion, but it is believed that the information is as complete as is necessary to issue instructions for the preparation of a complete project, or can at any rate very soon be made so by any one having authority to call for whatever may be needed to determine the sum total of accommodation to be provided.

Grouping of buildings.

63. For convenience of reference, the buildings have been grouped under five heads against each of which the estimated cost of the group is given as follows:—

		Rs.
(*a*) Residences for officials, including Government House, the residence of the Commander-in-Chief and those of local administrative and Municipal Staff	... ...	103,62,574
(*b*) Clerks quarters, both European and Indian	... ...	70,03,121
(*c*) Secretariat and other official buildings	... ...	86,03,030
(*d*) Miscellaneous public buildings	... ...	4,89,000
(*e*) Menials quarters	... ...	2,69,000
The total estimated cost is	...	2,67,27,065

Of this amount Rs. 2,26,823 represents the cost of the land, on which the residential quarters are situated, leaving a balance of Rs. 2,64,90,242 which represents the cost of the buildings less the cost of the land and the electric light and fan fittings which are the subjects of separate estimates.

Source of information as to buildings required.

64. The buildings required in each group are given in great detail in their respective group sub-estimate; the lists given were compiled from information, obtained from the various departments concerned.

Question of maximum permissible rent of official residences in Delhi.

65. Under the Public Works Department Code rules the rent of a residential quarter is so fixed as to return interest at 3½ per cent on the capital cost plus the cost of special and annual repairs.

For the purpose of this estimate the latter is taken as being 2½ per cent of the capital cost, thus making the maximum outlay permissible on the construction of a residence equal to the maximum permissible rent capitalised at 6 per cent. It is also laid down that the maximum rent permissible is Rs. 10 per cent of an officer's annual salary. But most officers will reside in Delhi only for 7 months in the year, and during the remaining 5 months they will live in Simla. The rents paid by them in Simla and Delhi, combined should be kept within Rs. 10 per cent of their annual salaries, if possible. Certain officials, such as Members of Council, a few Secretaries and a certain number of clerks live in official residences in Simla and pay rent to Government, but these form a very small proportion of those who will be affected by the annual migration from Delhi to Simla.

The remaining officials reside in houses, belonging to private landlords, and the rents of these show a tendency to rise, and many of them now live in hotels, clubs and chummeries. Although paying no rent to Government, they are nevertheless not freed from paying rent to private landlords. The rent of houses in Simla today is roughly one month's salary of an official or 8⅓ per cent on the annual salary so that the possibility of getting the combined rent paid in Simla and Delhi down to Rs. 10 per cent of salary does not appear feasible in any but a limited number of cases and all that seems possible is to aim deliberately to provide economical residences at Delhi.

Maximum permissible rent assessed for the purposes of the estimate.

66. Bearing these points in mind, therefore, the figure, which has been taken as being the maximum rent permissible in Delhi is Rs. 5 per cent on the annual salary of an official.

Maximum permissible capital outlay in this estimate.

67. On this basis the maximum outlay permissible is Rs. 5 per cent on an official's annual salary capitalised at Rs. 6 per cent.

Division of residential buildings into sub-groups and description.

68. Captain Roberts has divided up the residential groups (*a*) of paragraph 63 into six sub-groups, which he calls C, D, E, F (*i*), F (*ii*) and G, and type designs to give an idea of the accommodation in each sub-group have been prepared and are attached to their respective group sub-estimates.

Class C residences are proposed for Members of Council.

Class D residences are proposed for Members of the Railway Board, Secretaries to Government and any officers, whose pay is between Rs 5,000 and Rs. 3,000 per mensem.

Class E residences are proposed for additional and deputy secretaries for generals, colonels and officers whose pay is between 3,000 and Rs. 1,600 per mensem.

Class F (*i*) residences are proposed for assistant and under secretaries, whose pay is between Rs. 1,600 and Rs. 1,200 per mensem.

Class F (*ii*) residences are proposed for junior officers whose pay lies between Rs. 1,200 and Rs. 800 per mensem.

Class G residences are proposed for registrars, chief clerks, personal assistants and other officers whose pay is about Rs. 800 per mensem.

Plinth area rates of residential buildings taken in this estimate.

69. For Class C residences the plinth area rate is taken as Rs. 5 for the main building.

For Class D, E, F (*i*) and F (*ii*) residences the plinth area rate is taken as Rs. 3, and for Class G quarters as Rs. 2-12.

For the outbuildings of all classes the plinth area rate is taken as Rs. 1-4.

The reasons for adopting these rates are fully explained in the reports on the estimate.

Percentage of annual salaries of officials that the rent of sub-group buildings represents with explanation

70. Statement D, attached to the sub-estimate of group buildings gives the total cost of the various buildings including the cost of land (the value is taken as Rs. 113 per acre), the numbers of buildings of each class required, the monthly rent at Rs. 6 per cent on these values, and the percentage which this rent bears to the annual salary of the officials concerned. An examination of this statement shews that this percentage, with the exception of an officer on Rs. 2,000 per mensem in the class D group, an officer on Rs. 1,600 per mensem in the class E group, the whole of the officers in the class F (*i*), F (*ii*) and G groups, is below the percentage of Rs. 5 per cent.

Question of bachelor officers residences.

71. Captain Roberts has raised the question of bachelor officers occupying a married officer's residence together, and has suggested that only three-quarters of the total number entered as required should be first constructed, *viz.*, 27 class F (*i*) and 73 class F (*ii*) residences. This is certainly a point on which definite instructions are required before the final project estimate is prepared, and has been catalogued in the list of such points of reference.

The saving, in capital outlay, if Captain Roberts' suggestions were adopted, would be Rs. 5 18,790. It is becoming more and more the practice at home and abroad for people to chum or club together, and Mr. Lanchester drew attention to a system springing up at home of grouping quarters about a central dining installation; the life in quarters is private but the residents go to semi-public reserved rooms for their meals and amusements. Some such residential quarters should be very popular at Delhi among all classes and should lead to a distinct saving in original outlay.

Works included in plinth area rates.

72. It should be noted that in all these sub-estimates, the plinth area rate includes (*i*) sewage (*ii*) drinking water and (*iii*) irrigation water connections but does not include (*i*) electric light wiring nor the (*ii*) cost of land. Both of these latter are give in separate estimates, though the cost of land is shewn in the estimates, in order to enable the rents to be worked out. It may be noticed that tenants of government bungalows that are wired pay in addition to the charge for current, Rs. 8½ per cent on the capital cost of the electric installation. This is in addition to the rent and is not covered by the 10 per cent limit.

Cost of Government House.

73. The cost of Government House and staff quarters has been taken as 50 lakhs of rupees to include internal decoration, preparation of the site etc., but exclusive of land. This is a modest sum for so important a building but Mr. Lutyens thought he could provide the shell he desired for that; internal decoration suitable to the shell must be added decade by decade.

Cost of residences for His Excellency the Commander-in-Chief and staff.

74. The cost of His Excellency the Commander-in-Chief's residence has been taken as double that of a residence for a Member of Council or Rs. 1,14,000 exclusive of land. The detail of cost of residences for the Military Staff of His Excellency the Commander-in-Chief is given in statement E and amounts to Rs. 81,628 exclusive of land.

Cost of residences for administrative and municipal officials.

75. In statement F is given the details of cost of residences for the administrative and municipal authorities, amounting to Rs. 2,13,430 exclusive of land.

Cost of miscellaneous public buildings.

76. In statement G is given the details of cost of a miscellaneous list of official residences amounting to Rs. 24,059 exclusive of land.

Total cost of residences for officials.

77 In statement H is given the detailed and total cost of all classes of buildings in the group (*a*), it amounts to Rs. 1,02,26,152 exclusive of land, of which the value is Rs. 1,36,422 a Rs. 113 per acre.

List of of officials, who may, or may not come to Delhi.

78. In statement J is given a list of officials, who may possibly come to Delhi, but about whom nothing is yet definitely settled.

Division of clerks' quarters into sub-groups.

79. Turning now to Group (*b*) clerk's quarters, there are European and Indian Clerks.

For the European clerks four classes of quarters are proposed—

(*i*) Class A for superintendents on Rs. 500 per mensem.

(*ii*) Class B for clerks drawing from Rs. 500 to Rs. 300 per mensem.

(*iii*) Class C for clerks drawing from Rs. 300 to Rs. 200 per mensem.

(*iv*) Class D for clerks drawing from Rs. 200 to Rs. 100 and also below Rs. 100 per mensem.

For Indian clerks, five types of quarters are proposed.

(*i*) Class A for superintendents on Rs. 500 per mensem.

(*ii*) Class B for clerks on Rs. 500 to Rs. 300 per mensem.

(*iii*) Class C for clerks on Rs. 300 to Rs. 200 per mensem.

(*iv*) Class D for clerks on Rs. 200 to Rs. 100 per mensem.

(*v*) Class E for clerks drawing less than Rs. 100 per mensem.

Type designs of all these classes both European and Indian, are attached to the estimate, by Captain Roberts with his usual indefatigable energy and full details are also given in the report on the sub-estimate of this group.

Plinth area rates used for clerks' quarters.

80. The plinth area rates used, are—

(*i*) for the better class of European quarters, Rs. 2-4.

(*ii*) for other European classes, Rs. 2.

(*iii*) for the better class of Indian clerks' quarters, Rs. 2-4.

(*iv*) for Indian clerks drawing from Rs. 300 to Rs. 200, Rs. 2.

(*v*) for Indian clerks drawing from Rs. 200 to Rs. 100, Rs. 1-12.

(*vi*) for Indian clerks drawing less than Rs. 100, Rs. 1-8.

A through rate of Rs. 1-4 has been allowed for all out houses.

Percentage of annual salaries of clerks which the rents represent.

81. In statement B., and C., for European and Indian clerks respectively is given the cost of the buildings and of land, and the percentage which the rent at 6 per cent bears to the clerks' salaries.

It will be seen that for the European clerks this percentage varies from 6·5 per cent to 21·2 per cent and for Indian clerks from 4·4 per cent to 11·2 per cent.

As explained by Captain Roberts in his report, the smallest bungalow, suitable for each class of clerk, has been allowed for, and, in the case of clerks drawing say Rs. 90 a month, it is impossible to design a building which could be inhabited by a European, and of which the rent would be only Rs. 9 per mensem on a per cent basis.

Question of bachelor quarters for clerks.

82. The figures have been kept as low as possible and the loss to Government in taking 5 to 10 per cent of salary as rent under paragraph 919 Public Works Department Code, Volume I, will not be great, especially as some bachelor clerks

would almost certainly live together in one quarter, and so give a larger return to Government. The same question of the proportion of married and unmarried quarters to be provided as arose in the case of class E., officers, again arises here and requires instructions concerning it.

In the case of the Indian clerks, much more economical quarters, suitable for Indians, can be designed than those for Europeans, consequently the percentage is not so high.

The whole of the quarters have however been allowed for as married quarters, since all the clerks will almost certainly be married.

Possible reduction in number of clerks' quarters.

83. It should be noted that these estimates allow for the whole number of clerks, who would come with all the departments, whereas it is still under discussion as to whether or no the whole of the Army Head Quarters will be removed and also whether certain subordinate officers to the Commerce and Industry Department will come to Delhi. These estimates may therefore be taken as a maximum.

Cost of group (*b*) buildings.

84. The total cost of the clerks' quarters is—

	Rs.
(*i*) European clerks	25,58,708
(*ii*) Indian clerks	43,44,012
Total ...	69,02,720

exclusive of land which comes to Rs 1,00,401 at Rs. 113 per acre.

Secretariat and other office buildings.

85. Turning to group (*c*) secretariats and other office buildings, statement L., of the sub-estimate gives the offices to be allowed for.

The estimate has been based on the nett floor areas of the offices as obtained from detailed schedules of accommodation, which are not yet complete, as in the case of the Commerce and Industry Department the location of some of the subordinate offices being still under discussion. Allowance on the scale of existing offices having however been made in such cases. The Director General of Posts and Telegraphs has not yet been able to prepare a detailed schedule for his office, and consequently an assumption of floor area has been made. Allowance sufficient for the whole of Army Headquarters has been made.

Method of arriving at a plinth area for two-storied buildings.

86 Having thus arrived at the total floor areas of buildings the plinth area of a two-storied building has been arrived at by taking the nett floor area of rooms in the building, exclusive of corridor, verandah, staircase etc. This rule was obtained from Mr. H. V. Lanchester who also told us that in England the design of economical plinth areas had now reached a high state of efficiency ; at the same time it must be recognised that it may result in largely under estimating the cost of the size of the buildings, for instance, none of the imperial secretariats, Calcutta are so compact.

Plinth area rates for secretariat and other office buildings.

87. A plinth area rate of Rs. 15 for the more important blocks and Rs. 10 for ones less so has been taken.

Allowance in estimate for Stationery and Printing Offices.

88. A lump sum of only Rs. 50,000 has been allowed for the Stationery and Printing Offices as it is possible that these offices may not be transferred from Calcutta for many years.

Total cost of secretariat and other office buildings.

89. The total cost amounts to Rs. 86,03,030.

Description of miscellaneous public buildings.

90. Turning to group (*d*) miscellaneous public buildings, statement K. of the estimate gives the detailed list of such buildings.

The estimated cost of each building is only a rough approximation, as it is impossible at this stage to estimate more accurately.

The buildings are—

(*i*) Town hall, including office of the Enclave administrations also Public Works offices, office of Sanitary Engineer etc., amounting to Rs. 1,30,000.

(*ii*) Medical school and civil hospital, only Rs. 50,000 is allowed initially, as probably a small civil hospital will suffice for several years.

(*iii*) Veterinary hospital, Rs. 14,000.

(*iv*) Post and telegraph offices, Rs. 50,000.

(*v*) Central police and fire station, Rs. 20,000.

(*vi*) Sub post and sub police stations, Rs. 5,000.

(*vii*) Vegetable markets and meat markets, Rs. 10,000.

(*viii*) Dairy Rs. 60,000 including quarters for residential staff.

(*ix*) Quarters for municipal cattle and horses, Rs. 5,000.

(*x*) Quarters for municipal menials, Rs. 15,000.

(*xi*) Schools, Rs 10,000.

(*xii*) Cemeteries, Rs. 2,000 initially.

(*xiii*) Slaughter house, Rs. 3,000.

(*xiv*) Municipal minor officials, Rs. 20,000.

(*xv*) Cathedral and other churches—Government grant Rs. 80,000 and Rs. 15,000 respectively.

No provision has been made for an university, colleges, a high school, nor for an Oriental Research Institute and museum, as they are not likely to be considered a legitimate charge against this estimate.

The total of the estimate is Rs. 4,89,000.

Possibilities of economy in miscellaneous public buildings.

91. Although in many of these items only initial and not future development figures have been given and in some cases only fractional portions of the cost allowed, it is open to question whether some of these items are chargeable to this estimate, as possibly for some time to come existing buildings can be utilised for the purposes outlined. This is, at all events, a point for consideration.

Menials' quarters.

92. Turning to group (*e*) menial's quarters, the estimate allows for blocks of quarters to accommodate 1,800 menials, the remaining 143, for whom accommodation is asked, being necessarily accommodated on the premises of the office building, to which they belong.

Plinth area rates for menials' quarters.

93. The plinth area rate is taken as Re. 1, which rate is considered sufficient, as they will be built in large blocks.

The estimated cost is Rs. 2,69,340.

How designs are being arranged for.

94. It is assumed that Government will themselves construct all the buildings, mentioned in the estimate.

The action taken in regard to obtaining designs for the various buildings is as follows :—

(i) *Government House.*

It is believed that designs for Government House are being prepared by Mr. Lutyens in England.

(ii) *Secretariats.*

Draft terms of competition have been sent to the Secretary of State, in which it is proposed to advertise throughout the British Empire for competitive designs for one block of secretariat buildings. The idea of this initial competition is that it should be the means to the end of selecting architects, who seem likely to design what is required to suit Indian conditions, hence only one block of secretariat buildings is proposed to be given out to competitive design at first and not four blocks as proposed by Mr. Lanchester in his 3rd report. In this report Mr. Lanchester suggested the dates for the receipt of designs as February 1st 1913 (in the case of competitors in the United Kingdom) and March 1st 1913 (in the case of competitors in India). As the modified terms have already been despatched to the Secretary of State, it is hoped that these dates will not have to be postponed.

The premia offered are Rs. 4,500 Rs. 3,000, and Rs. 1,500 for the three best designs.

(iii) *Official residences.*

The Government of India invited by advertisement on the 27th July 1912 architects and others, residing in India, to submit competitive designs for residences to be erected at Delhi.

Five classes of residences are specified in the conditions.

(*a*) Class A cost not to exceed Rs. 40,000. Premia (1) Rs. 2,000 (2) Rs. 1,000 (3) Rs. 500.

(*b*) Class B 1 cost not to exceed Rs. 28,000. Premia (1) Rs. 1,500 (2) Rs. 750 (3) Rs. 375.

(*c*) Class B 2 cost not to exceed Rs. 35,000. Premia (1) Rs. 1,500 (2) Rs. 750 (3) Rs. 375.

(*d*) Class C cost not to exceed Rs. 20,000. Premia (1) Rs. 1,000 (2) Rs. 500 (3) Rs. 250.

(*e*) Class D, cost not to exceed Rs. 15,000. Premia (1) Rs. 700 (2) Rs. 350 (3) Rs. 175.

In addition, designs for the grouping of 12 to 16 bungalows of classes C and D type and their appurtenances on a site measuring 20 gunters chains by 15, having roads on all sides, are invited and premia of (1) Rs. 500 (2) Rs. 250 (3) Rs. 125 are offered for this.

Date for receipt of competitive designs for residences.

95. Designs are to be received not later than noon on the 7th December 1912.

Design of buildings still remaining to be arranged for.

96. It will be seen that no arrangements have yet been made for the designs of clerks' quarters, miscellaneous public buildings, office buildings (other than secretariats) or menials quarters, nor has any design been made or invited for any building, estimated to cost more than Rs. 50,000 with the exception of Government House, which Mr. Lutyens, it is believed, is now engaged upon. Action in this direction seems to be necessary, to ensure the commencement of work as early as possible.

Final lay out not yet ready.

97. The final lay out is the most important point, as on it depends the architectural treatment of large buildings, such as secretariats, and this lay out can not be decided on till after the return of the English experts in December 1912. It is understood that the experts are now engaged in working up their final plans.

Points needing instructions, programme of work and rates.

98. This will be given at the end of this report.

LIGHTING.

Necessarily approximate value of estimate no. VIII.

99. This report and estimate were to have been prepared by Mr. J. S. Pitkeathly, C. V. O., but although the latter officer worked with his usual energy at its preparation yet owing to the multifarious and very urgent works (in connection with the temporary accommodation of the Government of India at Delhi) which he is carrying out, he has been unable to complete the report and estimate in time to send with this general report. It is however essential to give the Government of India some idea as to what the cost of lighting would be. An endeavour has been made therefore from such information as is at the disposal of the engineer officers concerned in collecting information, to frame an estimate, which, it is hoped, will suffice for the present in giving some indication of what such cost will be and what action should be taken to secure the early preparation of the project. Mr. Pitkeathly's report and estimate will, of course, be completed and forwarded as a supplementary document.

Delhi Electric Tramways and Lighting Co., Ltd.

100. At the present time the City of Delhi together with the Civil Lines have electric light, and there is also a tramway service. These are the result of the enterprise of the Delhi Electric Tramways and Lighting Company Limited who have installed a steam plant. It is not at all certain to what extent, if any, this company could supply electrical energy for the lighting of the New Capital, or whether it would be desirable to leave the electrical supply to them. It is known that Mr. Pitkeathly considers that in equity some consideration should be shewn to them and that they might be helped by giving them the opportunity to light at least part of the new area, but in what direction such help should lie is a matter for experts, and Mr. Pitkeathly with his extended knowledge of Delhi and the existing plant, and with his experience during the Durbar will be able to help in this matter by a report, if it was considered desirable to call on him for one.

The United Provinces Power Association.

100. (*a*). An association has been recently formed in London, for the purpose of promoting a company for the exploitation of electric energy, obtained by water power on the Jumna river near the bridge on the road from Mussoorie to Chakrata. This association has obtained a concession from the United Provinces Government, by which the association is given the sole and exclusive right to use the water power of the river Jumna between the points where the boundary of the Tehri state and the Dehra Dun district meets the river on the left bank and the mouth of the Bharund Rau on the same bank, provided it is used only for the purpose of generation of electrical energy. The usual other conditions are set forth in the signed agreement.

Major General Beresford Lovett, C.B., R.E., who forms one of the Association, in a letter to the Secretary to Government, United Provinces, forwarding the stamped and signed agreements, sets forth some of the proposed lines of activtiy of the Association. Amongst these is the supply of electrical energy in bulk to the Delhi Electric Tramway and Lighting Co., Ltd. and he states that negotiations are in progress with the company. The result of these negotiations is not known, nor whether, in the event of this scheme not being carried out, the Association has any scheme for entering the field as a rival, but, in either event, it may be pointed out that the distance of the source of power from Delhi is 158 miles, and that the transmission over this distance, especially in a country liable to great atmospheric disturbances, would be in the nature of an experiment, and consequently the plant and transmission line would probably require very special designing, involving a considerable lapse of time before the supply of electrical energy could be established in Delhi. This point is again a matter for experts. Whether working as a separate company or whether supplying electrical energy in bulk to the existing company the whole supply of the new capital would depend on the safety of a transmission

line 158 miles long, and it is probable that it would be considered unsafe to rely entirely on this, and this would involve the establishment of a stand by of the nature of a steam plant in addition at Delhi itself. It is a point for electrical experts as to whether it would not be cheaper to establish a steam plant from the first, and not to depend at all upon water power.

The desirability of early action to obtain a preliminary report on the best means of supplying electric energy to the New Capital.

101. Before closing this subject it may be said that the question of the source of electrical energy appears to be one that does not concern the Delhi Town Planning Committee, and that it would be advisable for Government to inform itself of the various schemes through its own electrical experts, so that Government may be in a position to deal (with full knowledge of facts and figures) with companies desirous of supplying the electrical energy.

It is certain that no company will form unless it is assured of obtaining a fair return on its outlay, and Government, after obtaining through its own experts, the information outlined, will be in a position to give definite details to such companies, if it desires to encourage them, or, if private enterprise cannot be enlisted, they will know exactly the outlay that will have to be incurred, if Government themselves puts down the plant.

The need of electric energy during construction.

102. In days gone by, when big works were in progress, the use of portable steam engines, and the employment of bullocks and other animals, was the general rule, but, of recent years, especially in the Punjab, these forms of energy have been largely supplemented by electrically transmitted power, so that if it is considered desirable to use electricity during the construction of the new capital, it will be realised that early action to determine the most satisfactory source of supply is very essential.

The remains of the Durbar plant.

103. A large installation was erected by Government for the supply of electrical energy during the Coronation Durbar of 1911. Of these a considerable portion was purchased while the rest was hired. That portion which was purchased together with more recent purchases is now being used for the Temporary Works at Delhi (lighting roads, houses etc.) and this will eventually be available for the new capital, should Government in the end have to put down an installation themselves. As to what economies would eventuate from the use of this existing plant is one, on which Mr. Pitkeathly should be consulted, and doubtless this point will, in any case, be dealt with in detail in his report, which will follow.

Scope of estimate.

104. The estimate provides for the installation of electric light throughout the new capital, also for electric fans in the more important residences, and to a limited extent in the secretariat and other buildings.

The cost of power for irrigation and water supply schemes is not included as provision for power made in the respective estimates is sufficient whether steam or electric plants be installed.

Sub-heads of estimate.

105. The estimate has been split up for convenience into the following sub-heads :—

(1) Rentable buildings.
(2) Government House.
(3) Secretariat and other offices.
(4) Street lighting.
(5) Distribution.
(6) Generating station.

Lights and fans in rentable buildings.

106. A separate report and estimate in this connection has been worked out in very considerable detail with the aid of Mr. Meares, who was much interested in

the project and kindly gave valuable help. It does not appear necessary at this stage to make any further observations on this portion of the general estimate, except to remark that the detailed information given therein will be a valuable aid in arriving at the electrical energy required for the lighting and for the fans of the rentable buildings.

The cost is Rs. 8,27,918.

Lights and fans in Government House.

107. Until detailed plans of Government House are prepared, a detailed estimate of the number of lights and fans is necessarily impossible. For the purposes of this estimate, it is assumed that the number of points required will be four times the number required in a Member of Council's residence, giving a total of 228 points, and in addition 32 fans. This would start Government House in a modest way. Whether it is a reasonable sum to fix beyond which the engineers should not go in installing lights and fans must be left to the experts to decide.

The cost is Rs. 18,200 allowing Rs. 50 per point and Rs. 150 per fan.

Lights and fans in secretariat buildings and other offices.

108. In the secretariat now being constructed for the temporary accommodation of the Government of India at Delhi, the cost of lighting and of fans works out at a rate of Rs. 31 per 100 square feet, and this figure has been taken for the purposes of this estimate. The rate allows for all the main rooms being lighted, and fans installed in the rooms of officers and senior clerks at a probable cost of Rs. 4,45,780.

Street lighting.

109. There will probably be 67·23 miles of streets to light. It is assumed that the overhead system will be installed and that there will be 44 poles per mile giving a total of 2,958 poles. The cost of each pole is Rs. 60 erected, complete, but without the lighting brackets, which are allowed for at Rs. 25 each for the main avenues, at Rs. 15 each for 80 feet avenues, and at Rs. 5-8-0 each for other roads. The total cost of street lighting exclusive of the wires is therefore Rs. 2,04,551.

It should be noted that, until the lay out of avenues and roads is settled, it is not possible to say whether one line of poles is sufficient for each road. Possibly more may be required, especially for 200 feet avenues in which case, if this estimate is not to be exceeded, the number of miles of road to be lit must be cut down.

Distribution wires.

110. The quantity of copper used in lighting the Durbar area in 1911 was 331 tons, and, as the total area to be lighted in the new capital will probably be only one third of the total area lighted at the time of Durbar, an allowance of 150 tons is assumed to be on the safe side. With the price of copper wire at the present time in the neighbourhood of £ 80 per ton (that for the Durbar cost £ 70) the cost of the wire will be Rs. 1,80,000.

Cost of generating station.

111. The assumed requirements of electrical energy are :—

	Kilowatts.
Government House	50
Official residential quarters	400
Rajahs, shops bazaars and offices	200
Street lighting	150
Miscellaneous	150
Total ...	1,000

1,000 kilowatts is equivalent to 1340 horse power, and it is assumed that Rs. 1,000 per horse power will cover the cost of the generating plant (with spare sets) and the power house.

The cost is therefore Rs. 13,40,000.

No credit has been allowed for the remaining Durbar plant, which has been referred to in paragraph 103 of this report. This will doubtless be dealt with by Mr. Pitkeathly in his report.

Total cost.

112. Total cost is:—

		Rs.
(1) Rentable buildings	... ...	8,27,918
(2) Government House	... ...	18,200
(3) Secretariat and other offices	... ...	4,45,780
(4) Street lighting	... ...	2,04,551
(5) Distributing wires	... ...	1,80,000
(6) Generating station	... ...	13,40,000
	Total ...	30,16,449

Points needing instructions, programme of work and rates.

113. These will be dealt with at the end of this report.

TOOLS AND PLANT.

How the sum in estimate no. X is arrived at.

114. An estimate for Tools and Plant has not been prepared, as at this preliminary stage, such an estimate although tedious to work out would not give information of value in passing orders for the preparation of a project estimate, while it is well known that the sum obtained by basing the cost on a percentage of the total outlay on works, is very reliable. In this case the cost of the works may be taken as Rs. 412,78,726 one and a half per cent on this amount is Rs. 6,19,180. A provision of Rs. 6,00,000 is therefore included in the estimate.

Reason for including this sum in calculations for establishment.

115. It will be noticed that in calculating the cost of establishment charges as a percentage on works, the cost of tools and plant is included among the expenditure on works. This has been done solely with the object of arriving at a better idea of the work the establishment will need to do, owing to the special nature of a large part of the plant, a considerable amount of the time of the establishment will be occupied on it. An example of this is the purchase of second hand plant that needs careful inspection involving long journeys, and the laying of temporary tram lines, the erection of workshops etc.

Some economy possible from purchase of second hand plant.

116. As many large works in India are now nearing completion, it is possible that many of the tools and much of the plant could be obtained economically from them, this is a matter that should be gone into by a responsible expert working under the Chief Engineer, as soon as he is appointed ; for not only can money be saved to Government, but much progress is gained in obtaining on the spot what must otherwise be waited for from England. But previous inspection by a competent reliable mechanical expert is essential as second hand plant may conceal a rotten core under a goodly exterior ; as the intentions of native drivers are often better than their capabilities.

It may also be noticed that printed lists of surplus stores are seldom up to date, and a personal visit to big works about to close down and to the centres at which Railway Companies usually collect their plant not in use is essential, if good useful plant is to be secured.

SUSPENSE.

117. No estimate has been prepared under this head although one will be needed in the project, but for the purpose of this preliminary estimate the sum to be provided under suspense on the final project will be got from the estimates of the different works.

How dealt with in these estimates.

It is assumed that each work when completed will be relieved of its surplus stock by transfer or sale, or the works may be so organised that one stock account is maintained for the whole of the works and that any loss under stock will be debited to the works.

118. It should however be explained that the programme of works presently to be dealt with relies on some progress being made on the collection of materials during this cold weather; to this end an estimate should be at once framed and sanctioned to provide for the cost of opening up quarries, manufacturing bricks, collecting materials for lime and arranging for sidings so that they may be laid down as soon as the approximate position of the main buildings is known. It is also assumed that a Chief or Superintending Engineer with some staff will be posted to the work so that full advantage may be taken of the cold weather in preparing the project as well as in collecting materials.

Urgent need of action in starting the collection of materials.

PRELIMINARY INVESTIGATION, MAINTENANCE AND SANITATION DURING CONSTRUCTION.

119. An estimate may be expedient under this head to cover the cost of surveys and for the preparation of cross sections for roads, sewers, drainage lines, rising mains etc., and it is, therefore, explained that the cost of this is included in the various estimates. It is essential that accurate levels should be fixed at intervals over the area to be built upon to assist in the final lay out of buildings; this is a work that can be done at once, and should be started without delay. An estimate should, therefore, be prepared at an early date against which the cost can, in the first instance, be charged. Later on, when the project estimate is sanctioned, this estimate will be credited with the total amount, and the various estimates concerned debited with the correct proportions of the total expenditure.

Preliminary investigation.

120. It may be noticed that the admirable maps so rapidly prepared by the Survey of India, are estimated to cost Rs. 14,206, for levelling and topographical survey. It may not be realized at what short notice the Survey of India organized this survey, and quite at the end of the cold weather and with what speed the early copies of the map was got out; the fair drawn map has also been produced in the least possible time. The map has laid the foundation on which a good lay out for roads, drains, irrigation and water supply pipes can be expeditiously designed and is an enormous asset towards the future good progress on the works of the new capital. This survey will be made the basis of all future detailed surveys; special attention having been given to this by Lieutenant A. A. Chase, R. E., and Syad Zille Hasnain in fixing the topographical details and lines of levels by including all fixed marks on the map. It is urged that all future surveys on larger scales and extensions of this map be made by the Survey of India, so that the map may not deteriorate in accuracy and finish.

The admirable maps provided by the Survey of India.

121. Under this heading would come all sums spent on repairs and renewals to works that have been constructed and not at once handed over to the Delhi Enclave. The amount of such will not be heavy as it is probable that most of the residential quarters will be handed over and occupied as soon as they are constructed. From the date of transfer they will, presumably, be maintained by the Public Works Department from the annual grants for this purpose. The same will apply to roads, many of which will serve the occupied bungalows. As regards the maintenance of secretariat and other office buildings, it is unlikely that any of them will be completed in all respects until much before the time of occupation by the Government of India. So that the maintenance charges will be little if any. No separate provision is made in this report for maintenance

Maintenance during construction.

soon will have passed and time may therefore be taken to work out the designs; these are highly technical and present many difficult problems of a minor character that must be solved before the designs can be fitted closely to the buildings, compounds and roads to be ameliorated by this outlay. Moreover "specials" may need to be designed and manufactured and rates are easier if time can be given and last but not least the competition for labour and material will be reduced if work not essential at the start of the city is postponed. This postponement will not mean that the monsoon of 1916 must be borne without a sufficiency of drainage because the work can be started so as to secure this; the natural drainage system is likely to be effective till the buildings are well advanced and a sufficient sanitary organisation must be installed for the labour on works.

Estimate no. III. Irrigation.

Water to start avenues, parks and gardens will be one of the first demands as soon as the lay out is finally accepted; unfortunately the machinery and pipes must take time to make, and as Lieutenant Sopwith urges the plans for this work should be got out first of all to secure early delivery. If early orders are given on the points at issue to the staff working out the project it is hoped that the Secretary of State can be put in a position to call for tenders by the first of April next and in that case the plant should be delivered and laid by April 1915, or two years from the date of calling for tenders, previous to that there is nothing for it but to start the arboriculture on the water to be got by minor installations on the subsoil and from the canal.

Estimate no. IV. Water supply.

Similar remarks apply to the installations of the domestic water supply.

Efficient arrangements must be made for the water required for works, the labour on the works and the engineer and audit office staff to be housed on the spot. The best way to get this supply has yet to be worked out. Pumping from tube wells of the pattern designed by Mr. Ashford, Superintendent of the Canal Workshops at Amritsar, is the most hopeful source, failing this a connection with the municipal main must be laid.

Estimate no. V. Roads.

The development of works will be started as soon as a lay out is received; this will contain type plans and specifications; so that there will be no need for further delay; the setting out being simple and the labour required unskilled, the expenditure on this work can therefore progress "*pari passu*" with that on buildings. The planting of avenues will of course be dealt with as soon as transplants are ready; indeed a nursery has already been sown with the seed of suitable trees by Mr. de Montmorency, and is under the care of Colonel Cole and his gardeners.

Estimate no. VI. Parks.

The expenditure on parks will be of a preliminary character until irrigation arrangements are complete, but it may be possible to do some development with more advantage in one year than in another, the sum to be spent is not large and is likely to be evenly distributed throughout the period with some extra expenditure in the years irrigation becomes available.

Estimate no. VII. Buildings.

As has already been said the programme of progress is entirely governed by the buildings and it is essential to secure arrangements, for the delivery of detail plans and of materials in due time; it does not seem necessary to go into further detail on this point now. It is usual for the staff of a large work as soon as they get together to make a detailed programme of progress to be achieved and to calculate out the quantities of material and labour needed during each month over which the programme extends; it is hoped that the information already collected will enable this to be done.

Estimate no. VIII Lighting.

The early installations of electric lighting is a desideratum, but as explained in paragraph 100 the source of supply has to be determined; until then only purely temporary arrangements can be made. The same remarks apply to this as have been made on the irrigation and domestic water supply. The expendi-

ture will probably be spread fairly evenly over all years being in stores and plant from England.

Estimate no. IX. Establishment.

On the right selection and timely drafting in of the establishment depends not only the achieving of the programme of progress, but also the efficiency of the designs and quality of the work. By February or March things should be so far advanced that the establishment required for the work to be done, in the years of peak load (1914-1915) should begin to arrive, as already said a large body of workers are already on the spot finishing up the works required for the temporary buildings and many of these will have probably been drafted in to prepare the surveys and plans for the project. The whole staff needed for the year of maximum expenditure should be on the spot by October next, having taken whatever leave they need for two years to come so that there may be no interruption of local knowledge and personal acquaintance with contractors, labour, and the intricacies of design, all this is a part of the rudiments of the game and this digression is therefore abruptly ended.

Estimate no. X. Tools and Plant.

Great foresight and experience is needed in purchasing tools and plant; that these may be on the spot when needed and be of the kind required. In India the surplus of labour when the agriculturist does not need them is great and if this season can not be fully utilized owing to the absence of some essential plant the year is lost. This, too, is of the rudiments of the organization of a big work and will be attended to by the Chief Engineer as soon as he takes over. The expenditure will be much the same in the first two years and rapidly tail off after.

ESTABLISHMENT.

Reason for preparating estimate no. IX.

131. Since the work of construction is of a concentrated and somewhat novel character, it is probable that the cost of establishment will vary from the rate of 23 per cent on works, laid down in Code Rules, as the result of experience, all over India. An estimate in some detail seemed necessary as the figure got by the 23 per cent rule is very large; about one crore of rupees, and it will be very useful to know at once whether so large a sum will really be required; a programme of construction has, therefore, been framed and a suitable staff worked out.

Special points to be taken into account in forecasting the cost.

132. Novel features are the employment of experts from Home to design the lay out, and of architects to prepare the drawings of the buildings some of whose designs will be got by competition and others by commission. It is also possible that architects may be employed to supervise the work. Contractors of experience and standing too may be forthcoming to undertake to build according to the drawings and specifications on sealed contracts under penalties: whereas on large irrigation works the so called contractors are little more than labour agents depending on the staff for the proper supervision and instruction of their labour.

Effect of obtaining drawings of buildings by competition.

133. It is of some importance to calculate what the effect of these arrangements will be, the problem is not a simple one as some part, if not all, of the money saved on establishment by having experienced contractors with as much engineering knowledge as is needed to build, will be spent in the form of higher rates on the works themselves. In the same way, if architects are employed to supervise their own work, some part of the commission paid to them for this, must be spent over again on engineers to manage the contractors. Architects and engineers, who have gained their experience in England, find it difficult to understand that in India no order, that can be evaded, is carried out; and that the engineer-in-charge must expend even more energy than the contractor to get work done. This is one of those things that differs much in the East to the West that is learnt subconsciously by the Government official, who comes to India at an age when impressions are readily formed and acted on. At the same time the erection of fine buildings makes it necessary to have the advantage of the services of men who have in the same way been brought up on similar work at home. In the

estimate, now put forward, these difficulties are not quite fairly met: as no deliberate attempt has been made to definitely calculate the operation of these forces; the most that can be said for the estimate from this point of view is that it is put forward by thoughtful officers, who have reflected deeply on the problem, but have been too preoccupied with more important work to go more deeply into the arithmetic of the organization.

Facts on which the estimate is based.

134. The staff required for each official and their pay has been carefully gone into and tabulated in statement A of estimate no. IX. Mr. Bailey, the Audit officer, has kindly assisted in supplying information for this statement.

Ordinary staff required.

134. The staff considered to be necessary to meet the construction programme already fully discussed in the part of this report devoted to that subject is a chief engineer with three superintending engineers, each of the latter to have an average of three executive engineers, and each executive engineer, three assistants, and the latter the usual staff cf subordinates; details will be found in Captain Roberts' report and statements. In addition an architect of experience and standing will be attached to the chief engineer's staff to deal with architectural designs and get out designs himself through his staff. But it will be necessary for engineers and architects to co-operate in this if the staff is to be fully utilised during the time the designs and estimates are in hand. The architect will be needed to advise the Chief Commissioner on the minor designs put up for sanction and all matters affecting the appearance of the city.

The cost of experts and architects.

136. The expenditure on the Committee of experts has been estimated in detail and comes to Rs. 1,65,000; that of this office is Rs. 1,00,000; other special officers from time to time employed in connection with the Committee are likely to cost another Rs. 1,00,000. The prizes for competitions already arranged for will cost Rs. 21,600. The cost of fair drawing the selected design for a secretariat got by competition will cost Rs. 18,000.

It is difficult to estimate what will be eventuallv paid in commission to architects but it is assumed that Rs. 40,00,000 worth of buildings will be drawn out in detail by outside architects at a cost of Rs 1,20,000; the remaining buildings being drawn out by the staff: except Government House for which it is estimated that the architect will be paid Rs. 1,75,000. The total expenditure therefore on selection of the site, the preparation of a lay out and the design of the principal buildings and some bungalows is Rs 6 99,000.

Special staff provided for.

137. Some special staff is needed—an *Audit officer* and staff has been provided for under accounts, a sub-head of establishment.

The *Land acquisition officer* and his staff have been included and special *Colonisation officer* provided to give individual attention to the cultivators whose holdings have been vacated to make room for the Imperial City. These men are suddenly called upon to start life afresh with no preparatory training from which to gauge how best to set themselves up to advantage. Every effort is being made to supply them with land on which to build themselves new homes, but unless an officer of sympathy and with experience in such work is ever present to assist each one by timely advice and persuasion and to propose suitable remedies for individual cases of hardships, many cruel tragedies must be enacted within the precincts of the future capital.

For arboricultural work a gardening expert is needed who will require an assistant as the tract to be dealt with is large and work onerous; the whole beauty of the city depends on how he carries out the details of the plans.

It is also proposed to attach to the Chief Engineer an *officer qualified in law* to deal with contracts and such like work as much depends in having contracts clearly and promptly drawn out: this is not work that engineers busy in carrying out novel designs can be expected to make time for. In any case it is better that a specialist should draw up the contracts for all the engineers than that all the engineers should have to study how to prepare proper contracts There will be

other legal work on which this officer can be employed. *A sanitary officer* will doubtless be insisted on; the works being close to Delhi will be much visited; but on large works in the Punjab a special officer is not employed, the engineers attending to these details themselves. Perhaps some economy can be got by giving the Health Officer, Delhi, an allowance to supervise and advise on sanitary arrangements.

Master craftsmen or foremen masons, carpenters, etc.

138. Provision has been made for five British foremen on Rs 450 a month, most, if not all, to be got out from England; these men must be capable men of the artizan class selected as likely to be efficient in teaching the more difficult part of their trade to the native workmen. Very high class stone, wood and iron work will be required, and unless master craftsmen are obtained, really good work cannot be expected. Five is a small allowance but it is assumed that the firms of contractors will also have such men in their employ, otherwise they will not be able to satisfactorily carry out the specifications.

Percentage cost of establishment on outlay.

139. The drafting in of the staff has been discussed under the programme of construction and the year by year total of the estimated cost of the staff proposed is given in paragraph 128, it will, therefore, suffice to examine statement C of Captain Roberts' estimate and notice that in calculating the percentage of the staff on outlay he has omitted expenditure in England and included that on tools and plant but excluded land. This has been done to see whether the staff proposed is likely to be right as work in India will need more staff than that done at home. The staff provided amounts to 21·5 per cent on the expenditure forecasted for the first year of construction (1913-14) 9.3 in the second, 13.6 in the third, 21·4 in the fourth, and 30.7 in the final year.

The total outlay on establishment being 16.55 on the expenditure in India on works (less land but including tools and plant). The percentage on works (Rs. 4,12,70,380) both in England and in India less land and tools and plant is about 14.75, this is usual for this class of work and would indicate that the proposals made for staff taking into consideration the help to be got from architects paid on commission will be much the same as if the designs were prepared by the staff. But there can be no doubt that the results of employing experts in their own line selected by competition and nomination is likely to be better than engaging staff for architecture; it is at any rate in accordance with the practice of the profession in England.

The proportion by sub-heads of establishment is very close to that ascertained to be usual.

140. In the last paragraph of his report Captain Roberts has compared the proportion of establishment under the heads of direction, account and construction and finds that it is very close to the percentages got as the average for all India *viz.*, 9:3:34 respectively; this indicates that the scheme of establishment has been correctly proportioned.

POINTS ON WHICH INSTRUCTIONS WILL BE REQUIRED TO FACILITATE THE EARLY PREPARATION OF THE PROJECT.

141. Each officer has abstracted at the end of his report the above points and these will now be briefly recapitulated, in dealing with the programme of construction emphasis has been laid on the importance of placing an engineer officer, with a suitable staff to work at once to begin the preparation of the project estimate; if this is done it will be necessary to draft instructions for him at once.

Matters that require early attention from Government.

142. Before taking up these points the following matters that require the early attention of Government should be listed.

(1) The agency for supplying electric power.

(2) Whether an unfiltered irrigation water supply is accepted.

(3) If so whether the sewage effluent may be pumped up with the irrigation water.

(4) To what extent, if any, river and town improvements should come within the scope of this estimate.

(5) The same for the afforestation of the ridge.

(6) The same for diversions and remodelling of any part of the railway systems, the ceremonial station for instance as well as bigger or smaller alterations to existing things.

(7) To what extent, if at all, the construction of roads and avenues included in the lay out may be deferred to the future and thereby excluded from the project.

(8) To what extent park areas are to be developed during the currency of the project and what work should be definitely postponed to the future. It is obvious that this is a work on which an indefinite sum of money can be spent, it is necessary therefore to lay down how much may be done at the start leaving further development to be dealt with decade by decade as funds and experience dictate.

(9) In the matters of buildings it is important to arrive at an early decision on the limit to the rent that should be paid by each class of official so that the corresponding standard of building may be estimated for.

(10) It is also important to determine to what extent the practice of living in clubs, chummeries, hotels should be encouraged or utilised in reducing the number of buildings to be erected. It is felt that large savings may be made in all classes of quarters in this way and at the same time greatly reduce the cost of living to the individuals concerned and perhaps enable them to live in a way more to their taste.

(11) It is important to arrive at an early decision as to the sums which may be spent on the various public buildings, it is obvious that the accommodation being given the cost of the buildings may be varied over wide limits according to the self restraint or luxury employed in materials, workmanship, etc. In engineering parlance the plinth area cost needs to be fixed for the guidance of architects and engineers in design.

(12) To what extent administrative buildings will be constructed by this project, which these are to be and how much may be spent on each, *i.e.*, whether they are to be economically built, or to be made fine erections to accord with some other building that challenges comparison and so forth. This may involve an enquiry as to what extent the existing buildings can be utilised ; this may take time; neverthless it is necessary to know what sum is to be set aside under this head before the project can be completed.

(13) Government should exert themselves to arrive as quickly as possible at a final list of accommodation required. All departments of Government have taken much interest in these and with the help got by the persistent energy of Mr. de Montmorency and Captain Roberts the lists are far advanced towards completeness but the day of actual completion will be indefinitely postponed unless a master mind having the needed authority takes up the file and terminates the considerations being thoroughly gone into and arrives at a decision suitable to the merits of the case.

(14) Whether a sanitary installation of dry refuse carts, incinerators, latrines, bathing and dhobi ghats is a charge that should be made to the project.

(15) Whether the audit office will be debited to " 18 Administration " or to this project ; this has already been referred by Mr. Bailey.

(16) Where new roads run out into the country or enter the city the point at which the cost of construction ceases to be debitable to the New Capital and should be paid by the Local Boards or if at all.

Point on which the engineers preparing the project should be instructed.

143. The points on which the engineers preparing the project should be instructed may be enumerated estimate by estimate, omitting land which is already in process of being taken up.

The points have already been discussed in the individual reports and the more important dealt with in the general report.

Estimate no. II (a) Storm water drains.

(1) The route to be followed by the main outfall of the storm water drain.

(2) To what extent if any sewage may be allowed into the storm water drains.

(3) The rainfall run off to be provided for from different classes of catchments.

(4) The maximum velocity to be allowed in the storm water drains.

(5) A specification for the pitching of these drains.

Estimate no. II (b). Sewers.

(6) Whether sewage is to be water borne throughout the area.

(7) Whether a separate or combined system of sewers and storm water drains is to be designed.

(8) To what extent the bath rooms, etc., of the bungalows are to be connected to the sewers.

(9) The form of sewage disposal.

(10) To what extent the existing sewage form at Ferozeshah Kotla is to be remodelled and whether the cost is to be borne by these estimates.

(11) The method to be adopted for ventilating the sewers.

(12) The extent to which flushing is needed and how this should be effected.

(13) The extent to which expansion of population is to be provided for in designing the sewers.

(14) The technical points to do with the alignment of the sewers, the material to be employed in construction, the minimum sizes, velocities etc, etc, will suggest themselves to the sanitary engineer and medical experts of Government.

(15) Whether or no the cost of the sanitaray installation is a proper charge to the project.

Estimate no. II (c). Sanitary installation.

(16) If it is to be made, the class of collecting carts, incinerators, latrines, watering carts, etc, to be estimated for.

Estimate no. III. Irrigation.

(17) The question of the filtered or unfiltered supply and the use of the effluent has already been referred to in the previous paragraph as matters needing orders from Government.

(18) The extent to which canal subsoil and river supplies are to be utilised.

(19) Localities for which irrigation should be provided.

(20) Intensity of irrigation.

(21) Situation of pumping station and reservoir.

(22) course of power and class of pumps.

Estimate no. IV. Domestic water supply.

(23) Population for which drinking water is to be provided.

(24) Quantity of supply per head of the same.

(25) To what extent water will be required for irrigation, for instance the ridge, which is above the level of the irrigation scheme as at present proposed, and the cantonments.

(26) To what extent, if any, the existing water works should be utilised.

(27) Whether the capital cost and maintenance charges are to be proportioned out to the cantonments. New Capital and indian city extensions or the water be charged for in bulk as supplied.

(28) Where the intake works should be placed.

(29) Allowances to be made for evaporation and wastage from settling tanks and filters.

(30) Provision to be made for increased population.

(31) The type of settling tanks to be used, the length of time to be allowed for rest and the velocity of water, if continuous tanks are to be used.

(32) Whether slow or rapid sand filters are specified or a combination of the two and their rate of filtration.

(33) The type of engines and pumps to be used for the unfiltered and filtered water and the duration of daily pumping.

(34) The material to be employed in the construction of the rising main and whether a single or double line should be employed and whether distribution should be made from it or not.

(35) The site and size of the service-reservoir.

(36) The extent to which valves and meters are to be used on the distribution system.

(37) Whether a combined irrigation and domestic water supply scheme is to be estimated for or not.

Estimate V. Roads.

(38) The extent to which the construction of roads proposed in the lay out may be deferred to the future, has already been referred as a matter needing the attention of Government and doubtless the Committee will make recommendations on this as it is a matter well understood in town development schemes.

(39) The extent to which ridges should be adhered to in the lay out to facilitate drainage and reduce the cost of bridging, this will be dealt with by the Committee in their lay out.

(40) Where roads chargeable to this project should end and become chargeable to other bodies has already been referred to as a minor point needing the attention of Government.

(41) The alignment of roads; this is the lay out on which the Committee are at work.

(42) The cross section of each type of road, *i. e.*, its width, the arrangement of avenues, paths, walks, rides, lighting posts, gutters, sewers, irrigation and drinking water pipes, hedges, and what not. This too will be dealt with by the Committee.

(43) The specification, that is the material to be used and the dimensions to be employed.

Practise on these points is ever varying and the specification of what is considered to be the most suitable practise for Delhi will be furnished by the Committee.

Estimate no. VI. Parks.

(44) The extent to which park areas should be developed in the project is a point to which the attention of Government has been called in the preceding paragraph.

(45) The means to be employed for the irrigation of the different parks; this will largely depend on their final location, some may be economically done from the subsoil being too far removed from the irrigation mains to justify the expense of a branch main; others may possibly be quite well served from the canal; while others again might be only get-at-able from the domestic supply.

(46) Any information available of the cost of establishing parks and a specification of the work to be done will be most helpful.

(47) The extent to which levelling up is to be done, and whether any levelling down of mounds, etc, is desired.

(48) Whether any special arboricultural or horticultural treatment is needed to the old ruins that come inside the park areas and also to those that are isolated so as to show them up and add them to the amenities of the place.

Estimate no. VII. Buildings.

The most important points about buildings have already been referred to as matters needing early attention from Government; these are :—

(49) The percentage on pay that should be fixed as the maximum rent down to which the cost of the building should be kept for each class of residence.

(50) The extent to which clubs, hotels, chummeries are to be utilised in calculating the buildings required.

(51) The sums which may be spent on the different public buildings to guide the engineer and architect in the quality of the material to be employed.

(52) The administrative buildings to be built from the project and the character of their architecture.

(53) The need for a final list of accommodations for all class of buildings required at Delhi.

Assessors.

(54) It may be noticed that instructions on technical points are up to date because conditions for competitions have been got out, and Mr. H V. Lanchester devoted considerable time and thought to make these as complete as possible; further more these conditions provide that the assessors shall reply to all questions asked by the competitors. This accounts for the few minor points that are outstanding on this very large subject.

Estimate no. VIII. Lighting.

(55) The agency by which electric energy should be supplied has already been given as a matter that needs the attention of Government.

Mr. Pitkeathly's report is awaited and will be sent in when received; the following are the alternatives for which orders are needed.

(56) To what extent, if at all, power from the Delhi Electric Tramways Company, is to be utilised.

(57) What use is to be made of the Hydro-Electric syndicate, who have a concession from the United Provinces Government.

(58) What point, if any, of the installation on the Durbar site is to be utilised.

(59) What arrangements, if any, are to be made for electric power to drive plant during construction.

(60) The situation of the power station and other technical details may be left to be dealt with by Mr. Pitkeathly.

Estimate no. X. Tools and Plant.

(61) It is not proposed to catalogue any points under this head as plant can perhaps be left to be dealt with by the Chief Engineer, but it is necessary that an early start be made, in obtaining plant for sidings, railway trucks, stone cutting machinery (if needed) and so forth.

Estimate no. IX. Establishment.

(62) Establishment is outside the scope of this report and has only been dealt with in this preliminary report and estimate to obtain figures for the cost of building the New Capital and to substantiate a programme of progress on which the actual final outlay much depends.

RATES.

Where given.

144. Each estimate has attached to it a schedule of the rates employed in arriving at values, no useful purpose will be served by rearranging them and adding a schedule to this report as the rates for the same class of work sometimes differ according to the engineering purpose for which the work is done, and it will, therefore, be better to consult each schedule separately.

145. It has been assumed that the rates for labour and material will remain as at present throughout the currency of the works. This may be thought to be optimistic as the rise in the cost of living has been rapid of late years ; and it is thought by many to be still going on, at the same time extravagances are apt to be covered by the explanation that rates have risen.

Rise not anticipated.

146. Some well thought out arrangement to control rates will be required so that contractors may not play off cantonments, new capital and municipal staff one against the other; not to mention the large amount of work likely to be in progress by private enterprise.

Board of control needed.

CONCLUDING REMARKS.

147. Some words of acknowledgment are due to the cordial assistance at all times reeeived by the staff of this office from officials at Delhi and indeed from far distant places, calls for files, facts and figures being always promptly responded to ; among the former the following may be mentioned. Mr. T. Salkeld, Municipal Engineer, Delhi ; Mr. R. H. Sears, Resident Engineer, East Indian Railway ; Mr. C. B. Barrie, Executive Engineer, Southern Punjab Railway ; Mr. W. H. Scott, District Traffic Superintendent, Great Indian Peninsula Railway Mr. E. Home Purves, Executive Engineer and Mr. J. L. Sale, Assistant Engineer, Western Jumna Canal ; Mr. J. S. Hope, Executive Engineer of the Agra Canal ; Mr. G. Saunderson, Superintendent of Archaeology, Northern Circle, Agra ; Mr. A. C. Griessen, Superintendent, Taj Garden, Agra. For much of the hot weather many of these officers had a good deal of their time occupied in shewing the Experts over their work and in making observations, finding plans and supplying information.

Acknowledgment of cordial assistance received from various officers.

148. In paragraph 120 the promptness with which the Survey of India surveyed the tract and delivered early copies of the maps is recorded. The survey was organized by Colonel S. G. Burrard, R. E., C. S. I., F. R. S., and placed by him under the direction of Major C. H. D. Ryder, R. E., Superintendent of Northern India Survey. Lt. A. A. Chase, R. E., was the officer in charge of the party with Syed Zille Hasnain, Deputy Superintendent in charge of the levelling operations. The good work done received the cordial appreciation of the Committee. The work of reproduction both at Dehra Dun and Calcutta was quickly done. The usefulness of the maps being much improved by the valuable advice and help obtained from Major W. M. Coldstream, R.E., Superintendent of the Map Publication office, Calcutta.

The Survey of India.

149. In work of this sort it is exceedingly difficult to obtain quickly just the right men ; the surveys and drawing work have been greatly advanced by the promptness with which Mr. J. G. Davis, Superintending Engineer, Derajat Circle sent up Malik Jamal-ud-din, Sub-overseer and with which Mr. W. P. Sangster, Executive Engineer, Upper Swat River Canal, relieved B. Kushi Mohamed. More recently still Mr. F. E. Gwyther, Chief Engineer, has supplied a head clerk and Mr. F. C. Rose, Superintending Engineer, a head draftsman.

The help received from establishment promptly supplied by the Canal Department.

150. It will hardly have escaped attention that a preliminary estimate of the outlay on the new capital only became possible because the lists of accommodation required were as complete as they are ; this is largely due, as already said, in paragraph 142 (12) to the resistless energy with which Captain Roberts and Mr. de Montmorency have pursued the subject, and also to the interest taken in it by the departments concerned. These lists should now be made final ; it is difficult for the laymen to appreciate how much delay is caused by want of finality in a few items which to them may seem unimportant and not likely to have much influence on decisions. But this is not so and the authority of Government should be used to determine what should be the accommodation for which the project should be prepared.

The help got from the lists of accommodation required.

G. C. B. P., Simla.—No. 708 H. D.—14-11-12—55—J.K.

ESTIMATE No. I.

Purchase of Land ... ... Rs. 22,49,355.

ESTIMATE NO. I—LAND.

Report dated 21st September 1912 by Lieutenant G. E. Sopwith, R.E., on the estimate of the cost of acquisition of land.

LIST OF CONTENTS.

Report dated 21st September 1912 by Lieutenant G. E. Sopwith, R.E., on the estimate of the cost of acquisition of land.

1. The committee recommended that certain land in the vicinity of Delhi should be partly acquired and partly placed under restrictive control. These areas are shown on the map, accompanying the committee's report.

Committee's proposals.

2. The boundaries, which were shewn as straight lines on this map, have been slightly altered so as to follow village boundaries, and the map, which accompanies Major Beadon's report on the cost of land acquisition, gives the boundaries as now proposed, as well as the sub-division of the whole area into blocks, marked A, B, C, D and E.

Description of the blocks.

There is also an area to the north of Delhi, coloured green, and referred to by Major Beadon as "The Delhi city expansion tract."

Of these areas A is the cantonment site, B is the site of the imperial city proper, C is an area which will possibly be used for expansion and for other purposes not yet settled, D is the area for future development of the imperial City, E is the site for sewage farm, racecourse, parks, river frontage schemes, etc., while the area to the north will also possibly be utilised for expansion of the existing city on certain lines, referred to by Major Beadon in his report.

3. Although all these areas involve large expenditure on acquisition, it is only proposed in this estimate to consider the cost of acquiring blocks B and E, which will be needed for the construction of the imperial city from the start. Block A affects the Cantonment only, while the other blocks, it is assumed, will be treated as separate projects, the cost of the land being debitable to contemporaneous projects for future development, and not being a charge against the New Capital.

Land for new capital.

4. Although block E is included, a decision is required as to whether the cost of acquiring this block should be debitable to the new capital or to some other projects. The details, financial and otherwise, connected with each of these blocks are given in considerable detail in Major Beadon's report.

Block E area.

5. In this estimate the capitalisation of abatement of land revenue, and also of returns has been taken at 25 years' purchase. A return from new rents of land to remain agricultural temporarily of Rs. 18,272 per annum is calculated by Major Beadon. For the purposes of this estimate the capital value of this is taken at 5 years purchase, as it will probably be required for other purposes after that interval of time.

Capitalisation of proceeds.

6. Major Beadon has assumed a ground rent of Rs. 24 per acre per annum as returns from Class II land in block B, the Hon'ble the Home Member having suggested a ground rent of Rs. 10 per acre per annum. The financial difference caused by taking a ground rent of Rs. 10 per acre per annum has been shewn in the estimate.

Rate of ground rent for class II land.

7. It is assumed that the principle of premia will be adopted, and the estimate is based on this assumption.

Premia.

8. As regards block E, the revenue is at present derived from agricultural tenants, and as the sewage farm will be situated in this area, it is assumed that the new rents, calculuted by Major Beadon at Rs. 24,370 are likely to be received perpetually. For the purposes of this estimate therefore, the rental has been capitalised at 25 years' purchase. This is then, a point, on which definite instructions will be required when orders for preparing the project estimate are given.

Capitalisation of returns in block E area.

9. For the reasons given in paragraphs 3 and 4, only the acquisition of blocks B and E are considered in this forecast.

Area considered in forecast of expenditure.

10. It will be noticed that, in the estimate, no account is taken of interest on capital, the reason for this being that it is not known whether the acquisition will be financed from loans or from revenue. Furthermore the principle of premia has been assumed in the estimate, and this may be altered, thus increasing the annual ground rent, but necessitating the inclusion of interest charges on capital outlay, which outlay would be, in the case of block B, more than recouped by the receipt of premia.

Reasons for interest on capital outlay not being included in estimated cost.

11. If the principal of premia is adopted it is probable that no receipts from this source would be available till the end of 1913-14 at the earliest, as it would be advisable to completely organise all establishment, and to get the construction of Government buildings well in hand, before allowing private owners to start building operations, thus causing in all probability considerable difficulty to Government Engineers in keeping down rates, as private owners, desirous of an early return on their outlay, would be prepared to attract contractors and labour from Government works by the offer of abnormal rates. Such was in several instances the case during the Coronation Durbar of 1911, when the conditions prevented the temporary exclusion of private owners.

Probable earliest date for commencement of receipts from premia.

12. As a special acquisition officer is to commence acquiring the land on October 15th of the current year, all drawings from the Treasury will be made before the end of the current year. The whole expenditure in acquiring blocks B and E will therefore be incurred during the current year. The value of the homesteads has been included in the forecast, so as to be on the safe side, although Major Beadon assumed that some of them will not be acquired till later. In Major Beadon's report the value of subsequent outlay in acquiring homesteads is given as Rs. 91,770 for block B, and Rs. 1,32,710 for block E.

Forecast of expenditure year by year.

Neither Major Beadon's report nor this forecast allows for possible enhancement of cost of acquisition by the courts.

The capital outlay is therefore—

	Rs.
1912-13	22,49,355
Subsequent years	*Nil.*

Estimate No. 1 of cost of acquisition of block B for the New Capital.

	Rs.	Rs.
(1) *Outlay.*—		
(*a*) Cost of acquiring land	9,72,670	
(*b*) " " house property in abadis (homesteads)	4,53,215	
(*c*) Cost of redemption of assignments	60,960	
(*d*) Capitalisation of abatement of land revenue at 25 years' purchase (Rs. 13,734)	3,43,350	
(*e*) Capitalisation of abatement of Malikana (Rs. 2,592) ...	64,800	
		18,94,995
(2) *Returns.*—		
(*a*) Initial premia on class III land (Rs. 500 per acre) ...	4,24,000	
(*b*) Initial premia on class IV land (Rs. 5,000 per acre) ...	12,35,000	
(*c*) Capitalisation of agricultural rents at 5 years' purchase (Rs. 18,272)	91,360	
(*d*) Capitalisation of ground rents on class II land at Rs. 24 per acre per annum	12,16,800	
(*e*) Capitalisation of ground rent on class III land at Rs. 25 per acre	5,30,000	
(*f*) Capitalisation of ground rents on class IV land at Rs. 250 per acre per annum	15,43,750	
		50,40,910
Net capitalised profit resulting equals		Rs. 31,45,915
Net capitalised profit (if ground rents on class II land are taken at Rs. 10 per acre per annum) equals ...		Rs. 24,36,115

Estimate No. 2 of cost of acquisition of block E for the New Capital.

	Rs.	Rs.
(1) *Outlay.*—		
(*a*) Cost of acquisition of land	6,02,370	
(*b*) " " house property in abadis (homesteads)	1,32,710	
(*c*) Cost of redemption of maufis	27,430	
(*d*) Capitalisation of abatement of land revenue at 25 years' purchase (Rs. 8,381)	2,09,525	
		9,72,035
(2) *Returns.*—		
(*a*) Capitalisation of annual agricultural rents at 25 years' purchase (Rs. 24,370)	6,09,250	6,09,250
Net cost of land after crediting capitalised value of proceeds thereof		Rs. 3,62,785

ESTIMATE No. II.

			Rs.
(a) Storm water drains	...	...	15,00,000
(b) Sewers ...	...	...	8,55,000
(c) Sanitary installation	...	...	6,30,000
	Total	...	29,85,000

ESTIMATE NO. II (*a*)—STORM WATER DRAINS.

Report dated 25th September 1912 by Mr. T. R. J. Ward, C.I.E., M.V.O., superintending engineer on the storm water drains.

LIST OF CONTENTS.

N.B.—The above plans are in a separate cover or album.

Report dated 30th September 1912 by Mr. T. R. J. Ward, C.I.E., M.V.O., superintending engineer, on the storm water drains.

Separation of sewage and storm water.

As explained in the report on the sewage system the estimates are being framed to provide a separate system for sewage and for storm water.

Description of areas of catchment.

2. The map of catchment areas (Plan No. XII) shews that the site, with the exception of some park land around Safdar Jang, and the Khandrat tract lying between the Okhla Navigation Cut and the river is drained by two main systems of nalas, the Pahargunj and the Kushak that concentrate at the village of Babarpur ; the water parting between the systems is a line running from Sarbans Serai through the Raisina Hill to the 3rd milestone of the Gurgaon Road, and so on about due west to the ridge. The eastern boundary of the whole catchment is the Okhla Navigation Cut of the Western Jumna Canal that follows the water-shed ; the western is of course on the ridge. These two boundaries meet to the North in a line three quarters of a mile long lying between the Khadam Sharif and the Idgah. The southern boundary is about five miles long, and starting from the ridge passes through the Arakpur Bagmochi homestead to Alipur, where it turns North and reaches Babarpur in such a way as to exclude the area around Safdar Jang, while that around the Lodi tombs is included. The area of the total catchment is 10·94 square miles, the Paharganj series accounting for 4·13 and the Kushak for 6·81. The catchment areas of the tributaries have been obtained by planimeter from an advance copy of the map fair drawn in colours and are given in statement A and shewn on the map and the index of catchment areas (Plans Nos. XII and XIII).

Method of indexing the nalas.

3. The number of nalas to be dealt with in the New Capital area is so large, and the names on the map so few that it has been necessary to index them on the following system.—the initial letter of the main outfall nala or drainage is applied to all the tributaries ; S. for Shakarkui, the local name of the drainage that passes through the Burapula to the river ; D. for Dusghara, the series that drains the Cantonment and Du. for Durhalia in the extension of the indian city : tributary channels on the right bank of any main drainage are R, and on the left bank L. and are numbered and measured from the junction or outfall upwards. $\text{S}\,\cfrac{1\text{L}}{2\text{R}\,\cfrac{1\text{L}}{1\text{L}(2\text{R})}}$ is a remote branch of the Shakurkui drainage system being situated on the first left bank tributary above the junction with the river, 2 R. being the second branch on 1L, or the Paharganj nala, and $\frac{1\text{L}}{1\text{L}}$ is the left branch on its first left branch until finally the tributary in question is found on the right. 1 L (*a*), 1 L (*b*) are interpolated numbers due to these tributaries being thought to belong to the Paharganj nala but on following up the water after the rain of the 7th September it was found that the catchments in question entered the main or Shakurkui nala that comes from Kushak, and in these reports is called the Kushak Branch in contradistinction to the Paharganj (1 L).

The Khandrat area, and that drained by the Pilangi Nala. (S 3 R).

4. There are two tracts within the limits of the New Capital that do not drain to the junction at Babarpur village,* an area of about 3 square miles lying between the Okhla Navigation Cut and the high bank of the river which drains by many nalas to the creek under the high bank ; the tract is occupied by ruins of a former city and is known as the Khandrat. Many of the nalas appear to be streets and some are doubtless old artificial drains. The second area is drained by the nala from Pilangi village passing South and East from Safdar Jang and falling into the Shakurkui Nala abour five furlongs below the Junction at Babarpur village. The nala is lettered S. 3 R and has a branch S. $\frac{3\text{R}}{1\text{L}}$, it drains some park areas around Safdar Jang and the Lodi tombs, and about a square mile west of the Kutab road that it is not at present proposed to develop.

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* The temple shewn on the map at the junction is the village Khera not its Mandar as stated on the plans This will be corrected in the project proper.

Run off.

5. The expense of the storm water drains depend on the size they are made, *i.e.*, on the intensity of rainfall that they will carry off without overflowing into streets or compounds ; this again will be influenced by the relative level of the bed of the drains with respect to the ground surfaces and compounds ; in the lay-outs so far discussed no regard has been paid to the lie of the land with a view to getting the roads on the ridges, so that they and the compounds will drain freely to the natural nalas : in consequence in making trial designs to arrive at figures from which to estimate, the bed of the drains has been taken as low as possible, and a run off of one inch an hour has been assumed throughout. But should the layout be revised to release low lying areas from occupation that will be inconvenienced by the water standing on them it may be possible to reduce the size of the drains by allowing heavy showers to overflood the drains.

Points connected with river floods and local rainfall occuring together.

6. A brief glance at the conditions that obtain will draw attention to phenomina that the engineers who prepare the drainage and sewage project should study, and will enable suitable instructions to be given for, their guidance.

The records of the Western Jumna Canal have been utilised in the making up of diagrams (*vide* plan No. XIX) which illustrate year by year from 1900 to date the gauge readings of the river, as read at the East Indian Railway bridge at Delhi, and also the rainfall, summed for 5 days periods (shown by red dots).

As heavy local rainfall does not necessarily imply that an intense flood will at the time come down the river Jumna such floods being dependent almost entirely on the rainfall in the mountainous catchment area of the river, a further diagram (see plan No. XX) has been prepared with the object of showing at a glance the occasions, on which heavy local rainfall coincided with a high river.

On this diagram daily rainfalls exceeding three inches have been shown in figures with a circle round them, and floods of over R. L. 670 on the gauge at the railway bridge are also shown by figures giving the gauge reading to the nearest round figure against the dates on which the floods occurred.

The statement given below has been compiled from this diagram and it will be seen that on seven occasions during the period covered, intense local rainfall has coincided with a large river.

Year.	Month.	Rainfall inches per day.	River floods gauge on East Indian Railway Bridge.
1900	September	6	671 *
1900	September	4	669
1902	July	3	672 *
1904	September	7	below 669
1906	September	4	674 *
1908	July	4	669
1908	August	5	674 *
1909	June	4	below 669
1910	September	4	671 *
1910	October	6	670 *
1911	June	3	below 669
1911	September	7	Ditto.
1912	August	4	671 *
1912	September	7 (on 7th)	low rose to 672 (on 11th).

NOTE.—The occasions marked * are those, on which storm water would probably off flow into the river with some difficulty ; the occasions, not so marked are those, on which, owing to a low river, the off flow would be rapid.

The fall of 7 inches of rain in September, 1911, caused a great accumulation of water in low areas, and big flows in the natural drainage nalas, but all this water off-flowed rapidly and without appreciable heading up, owing to the river being low, *i.e.*, below gauge 669.

The fall of 7 inches of rain in 1912 occurred on September 7th, and the river did not rise to gauge 672 till September 11th, thus allowing all storm water from the New Capital site to escape into the river before the high river occured; in fact the nalas were dry before sunrise on September 8th.

In the event of a high river flood and heavy local rainfall coinciding, heading back of the storm water in the drainages would occur, and the information contained in the statement and its diagrams shows that, although not very frequent such occasions do occur, and the design of the storm water drainages must take account of the highest flood levels Investigation of flood marks on a flood 2 feet lower than the maximum, show that the water level of 'the river at the outfall of the Shakarkui Nala was 2 feet higher than at Humayun's tomb *i.e* the water level was 2 feet or more higher than it would have been, if the flood water, had alone been there and there had been no inflow from the nala

Such high flood levels have been carefully investigated and are marked on the accompanying map. The highest flood level on record is gauge 674·0 at the East Indian Railway bridge and this gauge corresponds to R. L. 673·1 (G. T. S. figures) which are used on the map.

In the event of detailed investigation of any points shown up by diagrams being carried out, the records from which the diagrams have been prepared, should be utilised, as the records of rainfall are written up on the following day, to that on which the rain fell, while flood records are written up at the time of the flood. As an illustration of the necessity of bearing this in mind, it may be mentioned that the rainfall recorded against September the 7th and 8th 1912, really fell between 6·0 A. M. and 11·0 P. M. on September 7th and, as already stated, all storm water had escaped from the New Capital site before sun rise on the 8th September.

Some salient features on the catchment of importance in designing drains.

7. The map of catchment areas shows that the area to be developed consists of a rocky ridge with many ravines some fifty feet higher than the alluvial, which slopes down, rapidly at first but more gently nearer the outfall, from the boundaries of the areas selected, which coincide fairly well with the watershed.

The configuration of the basin is rather like on oyster shell owing to these changes in declivity. A glance at the longitudinal sections of the nalas shows very clearly how great is the slope of the nalas in their upper reaches, and the gradual flattening out of the slopes.

The run off of the storm water is already very varied, as, especially in the upper reaches, most of the ground is rocky, while in the lower reaches much is under heavy cultivation, so that the rate and percentage of run off is very much greater near the sources of the nalas than it is nearer the outfall.

With the construction of the New Capital, however, the area will undergo many changes, which will affect the run off, the creation of macadamised roads, and the erection of houses having the same effect as though the ground was rocky, while areas such as parks and gardens will bear a very similar relation in the matter of run off to the present cultivated areas.

The natural outfall of the drainage of the area to be developed follows a tortuous course more or less parallel to the river, and after collecting the water from the tract about Mahrauli, finally discharges into the river opposite Kilokri.

The catchment is separated from the high bank of the river by the Khandrat area, which is about one and a half miles wide near the city walls, and half a mile wide at Babarpur. Below the high bank is a foreshore that is about half a mile wide at Purana Kila and a mile and a half wide where the deltaic cone of the Shakarkui or Barapula nala has protected the foreshore with its current and probably with a denser silt.

The foreshore.

8. The foreshore merits a few words of description, having been deposited by the river its edge tends to approach to the level of normal floods that spill over it and gradually raise the edge leaving the parts nearer the high bank at a lower

level; the drainage from the high land keeps a creek open under or near it which must be reckoned with in providing for the drainage of the catchment and in development of the foreshore and of the high bank near the foreshore. The highest flood levels were shown to Lieutenant A. A. Chase, R.E., who has recorded them on his map: the normal flood levels are indicated by the lip or high edge of the foreshore; the normal cold weather levels are shewn by the figures marked W. L. along the course of the river.

Normally the foreshore of any river has a slope in the direction of the river and one from the river edge to the creek under the high bank: these slopes are normal on the Bela or foreshore from the bridge down to about Humayun's tomb where the effect of the fan of the Shakarkui nala, that obtrudes itself on the foreshore as already explained, ends in the upstream direction, while both fan and Okhla weir affect the levels between Kilokri and the latter place. It should also be mentioned that the storm water from the Shakarkui nala also actually fans out over the river flood water, the heading up apparently being some 2 or more feet in a fairly high flood as mentioned in paragraph 5. The effect of the weir has been to reduce the slope of the river immediately above it and to abnormally raise the foreshore and perhaps to secure the deposit of a finer and more compact silt. The afflux of the weir is from 3 to 5 feet according to the working of the canal and the state of the floods and the flattening effect of this on the slope of the bela may be seen in the longitudinal section on plan No. X of the sewers.

Gradients and cross sections of drains.

9. The thoroughness with which the contours have been surveyed in by Lieutenant Chase and his men not only enable the drainages and watersheds to be drawn on the map, but also provide material for very useful longitudinal sections or profiles of the nalas, which give rough data to gauge the nature of the technical problem before the engineer, and provide figures for an approximate estimate of the probable cost of leading away the storm water. The longitudinal sections of all the important nalas have been drawn out in such a way that the grading best suited to the purpose in hand can be readily seen. These sections will be found on plans Nos. XV to XVIII; they have been graded and channels have been worked out on the assumption that one inch of rainfall per hour must be run off, and that the stone lining of the channels will provide a surface having a value of ·018 for Kutter's N. A table will be found as statement B. to this report giving the velocities for enough channels to shew the effect of using materials for the lining having a value of N. = ·018 and ·011 respectively, and of using different slopes. The profiles show that the slopes obtainable are such that the highest velocities admissible will be obtainable for the maximum discharge, and that in this respect the channels can be economically designed. In a geometrical lay out made regardless of the drainage lines broad channels working with sluggish velocities would be exceedingly expensive in culverts: whereas with the rapid fall obtainable the weirs or drops can probably be combined with the culverts.

It will be necessary to issue instructions for the guidance of the engineers on the material to be used, the form of cross section to be provided and the maximum velocity that may be allowed, as well as the run off to be provided for. Delhi quartzite was laid on the floor of the undersluices at Tajwala in 1896 and has been so much worn that it will need to be renewed in about 5 or 10 years hence. But the river boulders are exceeding hard and pass over the floor during many days in the year whereas these drains will only flow full bore for a few hours at a time and the water will not contain sand sufficiently hard to wear good quartzite (this stone needless to say needs careful selection); if the channels are made sufficiently strong there is no doubt that occasional velocities of 20 feet a second will do no harm to the stone; the channels should doubtless have a cunette that will scour with small supplies should offensive matter be thrown into the drains and the run off, to be provided for, will, I think, vary from about 2 inches in the bazar areas and on the high ground, to about 1 inch or even half an inch on lower lying park areas. It will be a matter for careful detailed comparative estimating whether it will be economical to get a high velocity by smooth dressing the stone, or to be content with a lower velocity to get off with the rougher surface more suitable to Delhi quartzite.

10. When Mr. Brodie examined the site he drew attention to the facility which the proximity of the junction at Babarpur village to the river gave for a direct cut to the river thereby shortening the outfall and improving the grades. This cut (*vide* plan No. XV) has been used in making a forecast of the probable cost of the storm water drains. Experience however shows that direct cuts to the river work badly: we know from observation that most tributaries flow up against the streams of the main channel into which they outfall, and it may be that engineers should imitate this and turn their cuts up stream. An alternative (*vide* plan No. XV) is to follow the creek under the high bank and discharge the storm water at Okhla picking up the Shakarkui nala on the way. This alternative might have conveniences to the sewage farm and to the improvements to the foreshore that are likely to be carried out in course of time, but its cost is likely to be more than the direct cut; but again it promises to work more efficiently and to be more economical in the end. The merits of these two alternatives, and indeed the third of sticking to and clearing out the Shakarkui nala itself and not making a cut to the river at all will need many months of careful and intelligent investigation before a right decision can be arrived at: in the meantime the alternative ways of arranging the main outfall is a subject on which instructions are required for the guidance of the sanitary engineers in preparing the project.

Main outfall drain.

11. The estimates as already noticed are based on the longitudinal sections (plans Nos. XV to XVIII) already referred to and on the cross sections given in plan No. XIV; mileage rates have been worked out for each section of channel got from the grading to provide for a run off of 640 cusecs per square mile and are given in estimate no. 3; the excavation extra to that in the mileage rate has been taken out from the profiles and is given in estimates nos. 4 and 5. The cost of excavating and pitching the drains is summarised in estimate no. 6.

The estimates.

The cost of culverts for the new roads has been entered in the road estimate; provision in this estimate being only made for existing roads that may need bridging. The estimate is divided into main outfall drain from Babarpur village to the river, and the cost of the tributary drains and is as follows:—

Main outfall drain

	Rs.	Rs.
Excavation and lining of channel	3,64,773	...
Provision for bridging channel etc.	35,227	4,00,000

Tributary drains.

	Rs.	Rs.
Excavation and lining of channels.		
Paharganj series	3,22,417	
Kushak series	5,71,701	
Clearing out Pilanji drains, draining the Khandrat and connecting the roads and compounds with the drains	2,05,882	11,00,000
Grand total of estimate		Rs. 15,00,000

12. If a larger average run off or flatter or deeper drains are finally decided on the above estimate will be exceeded; on the other hand the lay out is sure to be made to take full advantage of the facilities as well as avoid the difficulties of the lie of the ground for drainage and sewage disposal and it is likely that a cheaper system of drains can be got. In any case it will hardly be necessary to regrade and pitch the whole system at once; in some parts of the Capital the existing nalas will suffice for some years, to be eventually constructed from other funds. This is a point that can best be dealt with in the project.

Sufficiency or otherwise of the estimate.

13. It may be noticed that there are possibilities of lowering the flood levels between Purana Kila and Okhla by re-placing the weir by stoney gates; these cost Rs. 30 a square foot of gate area, all machinery and steel superstructure

The possibility of lowering the flood levels by remodelling the Okhla works.

included; such a remodelling of the Okhla works would cost some four or five lakhs of rupees. The crest of the weir (R.L. 656. 17) is 11 feet above the floor of the undersluices (probable bed of the river at this point), the afflux at the weir is from 3 to 5 feet, the replacement of the weir by stoney gates would probably lower the flood line enough to prevent the water overflowing the foreshore. But the improvement of the river frontage of Delhi, like that of the existing city, is work outside the scope of these estimates. It is only noticed as a point on which instructions might be given as to what extent, if at all, the question of river improvements should be dealt with in the project estimates. The matter would give a lot of work, the railway and canal authorities must be consulted and they could not be approached until a clear cut scheme had been formulated, this could only be done after a preliminary survey and investigation had been carried out.

Programme of work.

14. The programme of expenditure on storm water drains like that on sewers is based on the assumption that since the early completion of these works is not obligatory, there is no object to rush the expenditure and so tend to increase the rates by competition of volume of work in the years 1913-14 and 1914-1915 during which the buildings will be pushed on. This will give leisure to work up the schemes very thoroughly, and to place orders in advance for specials of any kind that are required. It may, therefore, be assumed that until the cold weather of 1914-1915, the work will be of a preliminary nature and that progress in earnest will be in the cold weather of that year and the hot weather of the year following: with the large body of labour by that time in residence at Delhi the progress will be very rapid once the buildings begin to approach completion. The programme may therefore be made as follows:—

Estimate.	1912-1913.	1913-1914.	1914-1915.	1915-1916.	1916-1917.
Rs.		Rs.	Rs.	Rs.	Rs.
15,00,000	Preliminary ...	1,00,000	5,00,000	7,00,000	2,00,000

The points on which instructions are required.

15. Instructions will be required on the following points to enable the engineers to proceed rapidly with the preparation of the project estimate.

(*a*) The run off to be provided from different classes of catchment.

(*b*) The maximum velocity to be allowed.

(*c*) The material to be used in pitching the drains.

(*d*) The specification or method of construction.

(*e*) Whether the nala beds are to be everywhere followed or diversions made in particular places; this will be a consequence or result of the lay out.

(*f*) The route to be followed for the main outfall drain *vide* paragraph 10.

The extent to which sewage may be allowed into the drains can be more appropriately considered under sewers.

The extent to which improvements to the river with a view to developing the foreshore are to be dealt with in the project, can be better dealt with quite separately under town or city improvements.

16. A schedule of rates used in this estimate is added as statement C. for the convenience of reference.

STORM WATER DRAINS.

Abstract of estimate.

	Rs.	Rs.
Main outfall drain *vide* estimate No. 2, 2 miles at Rs. 1,51,553 per mile ...	3,03,106	
61,66,650 c. feet excavation at 10 Rs. per 1000 c. ft.	61,667	
Bridges etc.	35,227	4,00,000
Tributary drains *vide* estimates Nos. 5 and 4. 25·1 miles at Rs. 3,378·55	8,47,816	
77,17,000 c. ft. excavation at 6 Rs. ‰ c. ft. ...	46,302	
Connecting compounds, roads etc., with tributary drains and improving Pilanji Nala and draining Khandrat area	2,05,882	11,00,000
Grand total ...	Rs.	15,00,000

Estimate no. 1. Excavation estimate of main outfall drains.

I	II					III	IV
Description.	FIRST LIFT OF 7 FEET TAKEN IN THE MILEAGE RATE.					Quantity.	Remarks.
	1st. 7 to 12	2nd. 12 to 17	3rd. 17 to 22	4th. 22 to 27	5th. 27 to 32		
	c. ft.	c. ft.	c. ft.	c. ft.	c. ft.	c. ft.	
From Babarpur's temple across the delta of Shakarkui Nala to Okhla.							
0 to 7900 13500 to 15500*	7300 1900 —— 9200 ×575	5800 —— 5800 ×625	2800 —— 2800 ×675	1750 —— 1750 ×725	300 —— 300 ×775	1,23,06,250	* Junction of Shakarkui Nala. Bed width 100 feet and depth of water 7·0'.
†15500 to 17500	1900 300 —— 2200 ×590					12,08,000	† Shakarkui Nala Junction to Okhla.
Total ...						1,36,04,250 c. ft.	@ Rs. 10 per thousand. = Rs. 1,36,043
Add mileage rate 2 miles @ Rs. 1,51,553 per mile							„ 4,54,659
Add cost of bridges etc. „ „							„ 39,298
Grand total Rs. ...							6,30,000

Estimate No. 2. Main outfall drain from Babarpur's temple direct to the river.

Description.	FIRST LIFT OF 7 FEET TAKEN IN THE MILEAGE RATE					Earth cutting.	Rock cutting
	1st 7 to 12	2nd 12 to 17	3rd 17 to 22	4th. 22 to 27	5th 22 to 32		
	c. ft.	c ft.	c. ft.	c. ft.	c. ft.	c ft.	c ft.
From zero to R D 5,360 ...	5000 × 575	3800 × 625	1800 × 675	1050 × 725	...		
	28,75,000	24,75,000	12,15,000	7,61,250	...	1,831 600	54,94,650*
						72,26,250	
From R. D 5360 to R. D 10950	Deduct	1 × 5600 ×	$\frac{25 + 15}{2}$	× 6 =	6,72,000 c. ft		
	Earth	work ...	...	...	...	11,59,600	...
					Net ...	6,72,000	54,94,650
				Grand to	tal ...	61,66,650	

Cost of 61,66,650 c. ft. @ 10 per thousand c ft	Rs 61,667
Add mileage rate two miles @ Rs. 151, 553 per mile = Rs.	„3,03,106
Add cost of bridges etc.	„ 35,227
Grand total Rs.	4,00 000

* Three quarters of the cutting through the Khandrat area will be equivalent to rock cutting.

STORM WATER DRAINS.

Estimate No. 3. Cost per foot run and per mile of pitched channel of different bed widths and depths, etc.

1		2		3		4		5		6		
SECTION OF CHANNEL.		EXCAVATION AT Rs. 10 PER ‰ C. FT.		PITCHING AT Rs. 10 PER % C. FT.		BALLAST AT Rs 5 PER % C FT.		MASONRY AT Rs. 25 PER % C FT		Total per foot run.	Contingencies at 5 per cent	Total per mile of 5,280 feet.
Bed width.	Depth.	Quantity.	Amount.	Quantity.	Amount.	Quantity.	Amount.	Quantity.	Amount.			
feet.	feet.	c. ft.	Rs. A. P.	c. ft.	Rs. A. P	c. ft.	Rs. A. P	c. ft.	Rs. A. P.	Rs A. P.	Rs. A. P.	Rs. A. P.
3	2	22	0 3 6	6	0 9 7	1	0 0 10	6 4	1 9 7	2 7 6	2 9 6	13,695 0 0
4	3	34	0 5 5	11	1 1 7	2	0 1 7	6 4	1 9 7	3 2 3	3 4 0	17,160 0 0
5	3	40	0 6 5	12	1 3 2	2	0 2 0	6 4	1 9 7	3 5 2	3 9 0	18,810 0 0
5	3½	50	0 8 0	13	1 4 9	3	0 2 6	6·4	1 9 7	3 9 0	3 13 0	20,130 0 0
5	4	50	0 8 0	15	1 8 0	3	0 2 6	6·4	1 9 7	3 12 0	4 0 0	21,120 0 0
6	3	44	0 7 0	13	1 4 9	3	0 2 4	6·4	1 9 7	3 7 8	3 10 5	19,332 0 0
6	3·25	46	0 7 4	14	1 6 4	3	0 4 0	6 4	1 9 7	3 7 3	3 11 3	19,552 8 0
7	5	100	1 0 0	20	2 0 0	4	0 3 0	6·36	1 9 7	4 12 6	5 0 0	26,400 0 0
8	3	50	0 8 0	16	1 9 7	3	0 2 4	6 4	1 9 7	3 13 6	4 0 6	21,285 0 0
8	4	100	1 0 0	19	1 14 6	4	0 3 0	6 4	1 9 7	4 11 0	4 15 0	26,070 0 0
8	4·25	75	0 12 0	19	1 14 6	4	0 3 3	6 4	1 9 7	4 7 3	4 11 3	24,832 8 0
9	3	60	0 9 7	17	1 11 2	3	0 2 4	6 4	1 9 7	4 0 9	4 4 0	22,440 0 0
9	3·25	65	0 10 4	18	1 12 9	4	0 3 2	6 4	1 9 7	4 3 10	4 8 0	23,760 0 0
9	4	75	0 1 0	20	2 0 0	4	0 3 2	6·4	1 9 7	4 8 9	4 12 3	25,162 8 0
10	4	100	1 0 0	21	2 1 7	4	0 3 2	6 4	1 9 7	4 14 0	5 2 0	27,060 0 0
10	5	100	1 0 0	24	2 6 6	5	0 4 0	6 4	1 9 7	5 4 0	5 8 0	29,046 0 0
10	7	150	1 8 0	30	3 0 0	6	0 5 0	6·4	1 9 7	6 6 6	6 10 6	35,145 0 0

STORM WATER DRAINS—*contd.*

Estimate No. 3. Cost per foot run and per mile of pitched channel of different bed widths and depths, etc.

1		2		3		4		5		6		
SECTION OF CHANNEL.		EXCAVATION AT RS. 10 PER ‰.		PITCHING AT RS 10 PER %.		BALLAST AT RS 5 PER %.		MASONRY AT RS 25 PER %.		Total per foot run.	Contingencies at 5 per cent.	Total per mile of 5,280 feet.
Bed width.	Depth.	Quantity.	Amount.	Quantity.	Amount.	Quantity.	Amount.	Quantity.	Amount.			
feet.	feet.	c. ft.	Rs. A. P.	c. ft.	Rs. A. P	c. ft.	Rs. A. P	c. ft.	Rs. A. P	Rs. A. P.	Rs. A. P	Rs. A. P.
11	5	100	1 0 0	25	2 8 0	5	0 4 0	6·4	1 9 7	5 5 7	5 9 6	29,335 0 0
11	6	200	2 0 0	28	2 12 10	6	0 5 0	6·4	1 9 7	6 11 5	7 0 0	36,960 0 0
11	7	150	1 8 0	31	3 1 7	6	0 5 0	6·4	1 9 7	6 8 4	6 12 6	35,805 0 0
12	4	90	0 14 4	24	2 6 4	5	0 4 0	6·4	1 9 7	5 2 3	5 6 0	28,380 0 0
12	5	109	1 1 4	26	2 9 7	5	0 4 0	6·4	1 9 7	5 8 6	5 12 0	30,360 0 0
15	5	128	1 4 5	30	3 0 0	6	0 4 9	6·4	1 9 7	6 2 9	6 8 0	34,320 0 0
16	5	150	1 8 0	31	3 1 7	6	0 5 0	6·4	1 9 7	6 6 0	6 10 0	34,980 0 0
17	5	150	1 8 0	32	3 3 2	7	0 5 7	6·4	1 9 7	6 10 4	6 14 3	36,382 0 0
20	4·5	200	2 0 0	32	3 3 3	6	0 5 0	8·5	2 2 0	7 10 3	7 14 3	41,662 8 0
20	5	162	1 9 11	36	3 9 9	7	0 5 7	6·4	1 9 7	7 2 9	7 8 0	39,600 0 0
25	5	200	2 0 0	40	4 0 0	8	0 6 5	8·5	2 2 0	8 8 6	9 0 0	47,520 0 0
25	6	250	2 8 0	43	4 5 0	9	0 7 0	8·5	2 2 0	9 6 0	9 14 0	52,140 0 0
25	7	250	2 9 7	45	4 8 0	9	0 7 2	8·5	2 2 0	9 10 9	10 2 6	53,625 0 0
30	6·25	300	3 0 0	48	4 13 0	9	0 7 0	13·5	3 6 0	11 10 0	12 2 0	64,350 0 0
30	7	300	3 0 0	49	4 14 5	10	0 8 0	13·5	3 6 0	11 12 6	12 4 6	64,845 0 0
35	5	300	3 0 0	52	5 3 3	10	0 8 0	13·5	3 6 0	12 1 3	12 10 3	66,742 8 0
42	7	400	4 0 0	64	6 6 6	13	0 10 0	13·5	3 6 0	14 6 6	14 14 6	78,705 0 0
52	7	500	5 0 0	77	7 11 7	15	0 12 0	13·5	3 6 0	16 13 3	17 5 3	91,492 8 0
100	7	900	9 0 0	137	13 11 3	27	1 6 0	13·5	3 6 0	27 7 3	28 11 3	1,51,552 8 0
100	10	1,200	12 0 0	144	14 6 0	30	1 8 0	13·5	3 6 0	31 4 0	33 0 0	1,73,240 0 0

STORM WATER DRAINS.

Tributary drains.

Estimate No. 4.—Excavation extra to that included in the mileage rate given in estimate No. 3.

Description.	Index letter.	Cross sectional area.	Length in feet.	Quantity in c. ft.	Total per drain in c. ft	REMARKS.
		Sq. ft.				
Main drain ...	S.	...	...	...		
52 bed width ...	...	(*a*) 825	2,000	16,50,000		
42 ...	...	(*a*) 457½	2,600	11,89 500		
30 ...	...	(*a*) 367	7,700	28,25,900		
25 ...	...	(*a*) 297	4,500	13,36,500		
Khushak Band ...	...	(*a*) 195	300	58,500		
" ...	...	(*b*) 245	250	61,250		
" ...	...	(*c*) 295	200	59,000		
" ...	...	(*d*) 345	150	51,750		
" ...	...	(*e*) 395	100	39,500		
" ...	...	(*f*) 445	50	22,250		
10 bed width ...	...	(*a*) 96½	2,200	2,12,300		
				75,06,450		
Deduction of existing channel	1 × 19,00 ×	$\frac{20 + 8}{2}$	× 7	18,62,000		
				Balance ...	56,44,450	c. ft.
Paharganj ...	S. L	*N.B.*—The existing nala is about 40 feet wide, all excavation is included in the mileage rate.				
Rakab Ganj drain ...	S. L	(*a*)	...	...		
20 Bed width ..	...	(*a*) 190	2,300	4,37,000		
8 " ...	...	(*a*) 101½	$\frac{800}{2}$	40,500		
5 " ...	...	(*a*) 82½	$\frac{1,200}{2}$			
			$\frac{3,200}{5}$	1,02,300	5,79,800	
Raisina drain ...	S. 1 L	(*b*)	All excavation included in the mileage rate.			
10 Bed width ...	S. 2 L	(*a*) 115	2,000	2,30 000		
		(*b*) 165	1,000	1,65,000		
5 Bed " ...	...	(*a*) 85	2,000	1,70,000	5,65,000	
Deduct existing channel	1 × 7,000 ×	$\frac{14+8}{2}$ × 6			4,62,000	
				Balance ...	1,03,000	c. ft.
Malcha drain ...	S. 3 L	...	...	...		
8 Bed width ...	...	(*a*) 100	4,250	4,25,000	4,25,000	c. ft.
Baghmochi drains ...	S. 4 L	...	All excavation included in the mileage rate.			
Drains ...	$\frac{\text{S. 1 L}}{\text{2 R}}$	(*a*) 85	1,000	85,000	95,000	c. ft.

ESTIMATE No. II (*a*)—STORM WATER DRAINS.

Description.	Index letter.	Cross sectional area. sq. ft.	Length in feet.	Quantity in c. ft.	Total per drain in c. ft.	REMARKS.
Talkatora Drain ...	S. 1 L 2 R					
16 Bed width ...	...	(*a*) 145	1,400 2 × 2	50,700		
10 " ...	...	(*a*) 115	1,900 4 × 2	27,312		
8 " ...	...	(*a*) 100	850	85,000	1,63,012	c. ft.
	S. 1 L 2 R (2L)	...	All excavation included in the mileage rate.			
Quarry drain ...	S. 1 L 2 R (1L)					
17 Bed width ...	...	(*a*) 150	4,000 2 × 2	1,50,000	1,50,000	c. ft.
	S. 1 L 2 R 1 L 2 L	...	All excavation included in the mileage rate.			
	S. 1 L 2 R 1 L 1L(1R)	...	All excavation included in the mileage rate.			
9′ Bed width ...	S. 1 L 2 R (1 L) (1 L)	...	...	...		
20′ " ...	...	(*a*) 110 (*a*) 162·5	300 2,600	33,000 42,250	72,250	c. ft.
	S. 1 L 3 R	...	All excavation included in the mileage rate.			

STORM WATER DRAINS.

Estimate No. 5.—Abstract of excavation extra to that included in the mileage rate.

Name of drain.	Serial letter.	Quantity at Rs. 6 per %° c. ft.	Amount in Rs.	REMARKS
Main drain	S.	56,44,450	33,867	
Rakab Ganj	S. 1. L. (*a*)	5,79,800	3,478	
......	S. 2. L.	1,03,000	618	
Malcha drain	S. 3. L.	4,25,000	2,550	
......	S. 1. L / 1. R	85,000	510	
Talkatora	S. 1. L. / 2. R.	1,63,032	978	
Quarry drain	S. 1. L. / 2. R. (1. L.)	1,50,000	900	
Panjkui drain	S. 1. L. / 2. R. (1. L.) / (1. L.)	72,250	433	
......	S. 4. R. / 1. L.	4,12,000	2,472	
......	S. 4. R. / 1. L. (1. L.)	82,500	495	
Grand total ...	...	77,17,032	46,301	

STORM WATER DRAINS.

Estimate No. 6.—Mileage rates and excavation drain by drain.

Name of drain	Index	Area drained in sq miles	Bed width of channel.	Depth of channel	Mileage rate. Rs per mile	Length in miles	Amount in Rs	Total by mileage rate Rs	Add excavation extra to mileage rate from statement No 3-A	Total for each drain in Rs	Total for Khushak and Paharganj series.
			feet	feet							
Main drain. Khushak series of drains ...	S.	6 81	52	7	91,492	3/8	34,309	...	...	...	
			42	7	78,705	½	39,353	...	...	...	
			30	6 25	64,845	1½	97,267	...	..	...	
			25	6	52,140	7/8	45,622		.	..	
			10	5	29,040	3/8	10,890	2,27,441	33,867	2,61,308	
......	S. 1 L. (*a*)	1'24	25	5	47,527	1	47,527	...	. .	...	
			20	4½	41,662	¼	10,415	. .	.	...	
			8	4¾	24,832	11/16	17,072	...	...	...	
			5	3½	20,130	13/16	16,356	91,370	3,479	94,849	
......	S. 1 L (*b*)	0'55	10	4	27,060	9/16	15,221	...	...	...	
			8	4	26,070	3/16	4,888	..	...	...	
			6	3¼	19,552	5/32	3,055	...	. .	...	
			5	3	18,810	7/32	4,115	27,279	*Nil*	27,279	
......	S. 2 L	0'66	10	4	27,060	¾	20,295	...	...	..	
			5	4	21,120	5/8	13,200	33,495	618	34,113	
......	S. 3 L.	0'59	8	4	26,070	¾	19,552	19,552	2,550	22,102	
......	S. 4 L.	1'29	8	4	26,070	5/8	16,294	..	.	..	
			5	3	18,810	1/3	6,270	22,564	*Nil*	22,564	
......	S. 4 R. / 1 L	1'31	20	5	39,600	1/8	4,950	...	...	...	
			15	5	34,320	7/16	15,015	...	...	..	
			12	4	28,380	13/16	23,059	.	..	.	
			9	3	22,440	7/8	19,645	62,669	2,472	65,141	
......	S. 4 R. / 1 L. (1 L.)	...	10	4	27,060	3/8	10,148	...	...	...	
			8	3	21,285	¾	16,643	...	...	...	
			4	3	17,160	½	8,580	29,371	495	29,866	
......	S 4 R	...	9	3 25	23,760	5/16	7,425	...	. .	...	
			5	3	18,810	3/8	7,054	14,479	..	14,479	5,71,701
Paharganj series of drains ...	S 1 L.	4'13	30	7	64,845	1/16	68,898	...	...	...	
			11	6	36,960	15/16	34,650	1,03,548	*Nil*	1,03,548	
......	S. I L. / 1 R.	...	5	4	21,120	¾	15,840	15,840	510	16,350	
......	S. 1 L. / 2 R.	1'18	16	5	34,980	¾	26,235	..	...	...	
			10	4	27,060	3/8	10,148	...	...	...	
			8	4¼	24,832	5/8	15,520	...	..	...	
			4	3	17,160	1/8	2,145	54,048	978	55,026	
......	S. 1 L. / 2 R. (2 L.)	0'40	6	3	19,222	1/8	2,403	...	...	...	
			4	3	17,160	¼	4,290	6,693	*Nil.*	6,693	

Lower reach	S. 1 L. / 2 R. (1 L.) / 1 L.	...	4	3	17,160	½	8,580	8,580	*Nil.*	8,580	
......	S. 1 L. / 2 R. (1 L.) / 1 L. (1 R.)	0·16	5 3	3 2	18,810 10,890	3/8 5/16	7,054 3,403	... 10,457	*Nil.*	10,457	
......	S. 1 L. / 2 R. (1 L.) / 1 L.	0·22	35 20 10 9 4	5 4 5 4 3·75 3	66,742 41,662 27,060 24,832 17,160	1/8 13/16 3/16 5/32 ¼	8,343 33,850 5,074 3,880 4,290	 55,437	 433	 55,870	
....	S. 1 L. / 3 R. / S. 1 L. / 2 R. 1 L.	1·27	4 17 12 9	3 5 5 4	17,160 36,382 30,360 25,162	1 13/16 3/16 ½	17,160 29,560 5,692 12,581	17,160 47,833	*Nil,* 900	17,160 ... 48,733	3,22,417
Total ...	...	...	...	..	...	25 11/96	8,47,816	8,47,816	46,302	8,94,118	8,94,118
Grand total ...	...	...	...	...	...	.	...	...	...		8,94,118

Add cost of connecting compounds and roads with the tributary drainage system and of improving the Pilanji Tributary (S. 3 R.) and draining the Khandrat area 2,05,882

Grand total Rs ... 11,00,000

Cost of tributary drains per square mile of area drained and per mile of length

$\frac{\text{Total cost tributary drains}}{\text{area square miles}} = \frac{\text{Rs } 8,94,118}{10.94}$ = Rs, 81,729 per square mile drained.

$\frac{\text{Total cost of channels}}{\text{Total length of tributary drains in miles,}} = \frac{\text{Rs. } 8,94,118}{25\frac{11}{96}}$ = Rs 35,602 per mile of drain.

The rates for Khushak series are $\frac{\text{Rs } 5,71,701}{6.81 \text{ sq miles}}$ = Rs. 83,950 per square mile drained

$\frac{\text{Rs } 5,71,701}{14.9 \text{ sq miles}}$ = Rs. 38,370 per mile of length.

The rates for the Paharganj $\frac{\text{Rs. } 3,22,417}{4.13 \text{ sq. miles}}$ = Rs. 78,067 per square mile drained.

$\frac{\text{Rs. } 3,22,417}{10.2 \text{ sq. miles}}$ = Rs. 31,610 per mile of length

STORM WATER DRAINS.

Statement A.—Catchment areas of nalas.

Name of nalas	Designation of nalas	Catchment area in square miles	CATCHMENT AREA ABOVE JUNCTIONS: Junctions of branches with one another	Junctions of minor branches with major branches	Junction with main nalas	Total of catchment area in square miles	REMARKS
Charagh Delhi and Mubarikpur nalas.	S 1 R & S 2 R	38 08	..		...	38 08	
Pilanji nala ..	S. 3 R & S 3 R. / 1 L.	2 32	...	. .		2·32	
Khushak series of nalas.							
Shakarkui or Barapula .	S (Upper reach) & S 5 L	0 83	...	...	0 83	...	
...	S 4 L. / 1 L.	0 27	...	...	. .	...	
Baghmochi	S 4 L. ...	0 61	0 88	...	..	...	
...	S 4 L (*a*) ...	0 41	1 29	..	2 12	...	
Malcha	S 3 L. ...	0 59	...	...	2 71	...	
...	S. 2 L ...	0 68	...	...	3·39	...	
Shakarkui or Barapula Nala	S (Lower reach)	0 32	...	...	3 71	...	
Rai Sina	1 L. (*b*) ..	0 55	...	...	4 26	...	
Rakab Ganj	1 L. (*a*) .	1 24	.	...	5 50	...	
...	S. 4 R. / 1 L. (1 L.)	0·42	..	..	...	...	
...	S. 4 R. / 1 L.	0 59	1·01	...	...	..	
...	S 4 R. .	0 30	1·31	...	6 81	6 81	Total of Khushak series of Nalas.
Paharganj series of nalas							
Tal Katora	S. 1 L. / 2 R. (2 L.)	0·40	...	...	...	...	
...	S. 1 L. / 2 R.	0 78	...	*1 18	...	*1·18	* S. 1 L. / 2 R. Branch.
...	S 1 L. / 2 R. (1 L.) / 3 L.	0 09	...	...	...	...	
Kalali Bagh	S 1 L / 2 R. (1 L) / 2 L.	0 24	...	†0 33	...	...	† S. 1 L. / 2 R. (1 L.) (Tributary of
...	S. 1 L. / 2 R. (1 L.)	0 48	...	†0·81	...	...	
Panj Kui	S 1 L. / 2 R (1 L.) / 1 L (Upper reach)	0·22	...	...	...	...	
Bhola Bhattiara ...	S. 1 L. / 2 R. (1 L.) / (1 L.)(1 R.)	0 16	0·38	...	...	...	

STORM WATER DRAINS.—contd.

Statement A.—Catchment areas of nalas.

Name of Nalas.	Designation of Nalas.	Catchment area in square miles	CATCHMENT AREA ABOVE JUNCTION.			Total of Catchment area in square miles	REMARKS.
			Junctions of branches with one another	Junctions of minor branches with major branches.	Junction with main nalas		
...	S. 1 L 2 R. (1 L) 1 L.	0·08	0 46	...	2·45	...	
...	(Lower reach) S 1 L (Upper reach) S 1 L. 3 R. S. 1 L 4 R. S 1 L. 5 R.	1·23	...	..	3 68	...	
Paharganj	S 1 L (Lower reach) S 1 L 1 R	0 45	...	...	4·13	4·13	Total of Paharganj series of nalas
		...	...	...	...	10 94	Total area of catchment at Babarpur main drain
...	......	...	...	..	...	51 34	Total catchment at Barapula on Shakarkui nala

STORM WATER DRAINS.

Statement B—Discharge and velocity tables for slopes of one, two, three and four feet per thousand and for values of N. of ·018 and ·011 and the bed widths likely to be used at those slopes.

Bed Slope ·001.

N= ·018				N=. ·011.			
Bed width	Depth	Discharge cusecs	Velocity feet per sec.	Bed width.	Depth.	Discharge cusecs	Velocity feet per sec
feet 100	feet. 7	6,301	8 69	feet. 100	feet. 7	10,033	13·83
"	5	3,680	7·36	"	5	5,924	11·58
"	3	1,600	5·26	"	3	2,636	8 67
90	7	...	...	90	7	...	...
"	5	...	...	"	5	...	...
"	3	...	...	"	3	...	...
80	7	5,004	8 55	80	7	7,974	13 63
"	5	2,923	7 10	"	5	4,717	11 46
,	3	1,278	5 22	"	3	2,104	8·60
70	7	...	...	70	7	...	...
70	5	...	...	"	5	...	...
"	3	...	...	"	3	...	...
60	7	3,712	8 34	60	7	5,926	13 32
"	5	2,175	6 97	"	5	3,513	11·26
"	3	950	5·14	"	3	1,568	8·48

Bed Slope 002

N=. ·018				N=. 011.			
Bed width.	Depth.	Discharge cusecs	Velocity feet per sec	Bed width	Depth	Discharge cusecs	Velocity feet per sec
feet. 50	feet. 7	4,346	11 62	feet 50	feet. 7	6,941	18·56
"	5	2,545	9 68	"	5	4,114	15·65
"	3	1,114	7·21	"	3	1,839	11·90
40	7	3,442	11 31	40	7	5,505	18·09
"	5	2,018	9 51	"	5	3,265	15·38
"	3	881	7·07	"	3	1,461	11·73
30	7	2,546	10 88	30	7	4,082	17·45
"	5	1,495	9 21	"	5	2,424	14·93
"	3	657	6 92	"	3	1,089	11·46
20	7	1,669	10 16	20	7	2,690	16·38
"	5	977	8 68	"	5	1,592	14·13
"	3	428	6 63	"	3	711	11·02

Bed Slope 003

N=.018				N= 011			
Bed width	Depth	Discharge cusecs.	Velocity in feet per sec	Bed width.	Depth.	Discharge cusecs	Velocity in feet per sec.
feet 30	feet. 6	2,444	12 37	feet 30	feet. 6	3,943	19 95
"	4	1,278	9 97	"	4	2,148	16 32
20	6	1,595	11·56	20	6	2,584	18 74
"	4	832	9 46	"	4	1,368	15 55

Bed Slope ·004.

N = 018				N = 011			
Bed width.	Depth,	Discharge cusecs	Velocity in feet per sec	Bed width	Depth.	Discharge cusecs.	Velocity in feet per sec.
feet. 12	feet 5	810	11 18	feet 12	feet 5	1,328	18 34
"	3 25	403	9 13	"	3·25	672	15 21
"	2 5	263	7 94	"	2 5	443	13 34
10	5	672	10·77	10	5	1,105	17 71
"	3 25	333	8 81	"	3 25	556	14·71
"	2·5	217	7 70	"	2 5	366	12 98
8	5	537	10 20	8	5	886	16·83
"	3·25	263	8 41	"	3 25	441	14 09
"	2·5	171	7 38	"	2 5	290	12 49

STATEMENT C.

Schedule of rates used in this estimate.

	Rs
Excavation for pitched flume of all drains	10 per 1,000 c. ft.
Excavation of channel above pitched flume of main outfalls	10 per 1 000 c. ft.
Do. do. do. tributaries ...	6 per 1,000 c. ft.
Stone ballast under pitching	5 per 100 c. ft.
Stone pitching	10 per 100 c. ft.
Stone masonry	25 per 100 c ft.
Cost of drains	from Rs. 78,000 to Rs. 84,000 per square mile drained.
Cost of drains	from Rs. 32,000 to Rs 38,000 per mile.
Stoney gates complete with machinery and steel superstructure	at per square foot of area of gate Rs. 30.
Value of Kutter's N for pitched flume	·018
Rainfall run off per square mile about one inch an hour ...	640 Cusecs.
Maximum velocity admissible in drains for maximum discharge	20 feet per second.

Report dated 28th September 1912 by Mr. T. R. J. Ward, C.I.E., M.V.O., superintending engineer, on the estimate of sewers.

LIST OF CONTENTS.

Plans. (*These are in a separate album or cover*).

			Scale.
Plan No.	VI.	Map of sewers	4″ to 1 mile.
„ „	VII.	Diagram of sewers	none.
„ „	VIII.	Bheron-ka-Mandar (2 R), Boring No. $1\frac{(2\ R)}{1\ L}$. Boring No. $4\frac{2\ R}{1\ R}$, Salimpur $\frac{1\ R}{1\ R}$, Safdar Jang (1 R).	
„ „	IX.	Main sewer (S), Talkatora (4 L.) Boring No. 2 (3 L), Raisina (2 L.) Rifle Range $\frac{(1\ L)}{1\ L}$, Khandrat $\frac{1\ L}{1\ L\ (1\ R)}$.	
„ „	X.	Narhaula (1 L), Zabataganj $\frac{1\ L}{1\ R}$. Kalali Bagh $\frac{1\ L}{3\ L}$, Paharganj $\frac{1\ L}{2\ L}$.	

Report dated the 28th September, 1912 by Mr. T. R. J. Ward, C I.E., M.V.O., superintending engineer, on the estimate for sewers.

Description of the main features of area to be sewered.

The description of the area selected for the New Capital given in paragraphs 2,7, and 9 of the report on storm water drains shews that it coincides very closely with a drainage basin having an unusually large number of well defined nalas with sharp slopes approximating to 1/100 in the higher parts to be built on, 1/300 in the intermediate areas and 1/1000 in the broad stretches of cultivated land near the outfall at Babarpur-ka-Mandar, the Hindu temple at the junction of the nalas that come from Paharganj and Khushak. The tract, therefore, presents facilities for carrying off the storm water and sewage separately, and the estimates have been got out on the assumption that so far as possible this will be done.

Extent to which sewer and storm water drains may be used to supplement each other.

2. It may be convenient at places to use the sewers for carrying off rain water from offices and other buildings especially as they must be made of a size larger than is needed for the sewage in order to get minimum dimensions for cleaning and flushing purposes ; the storm water will not come regularly enough to be of more than occasional service for flushing. The use of the storm water drains as sewers will probably be avoided as the flow will eventually pass through the parks and out near the parts of the New Capital that will be visited by those driving and riding as well as by sight seers.

Self cleansing velocities and flushing.

3. A table of discharges and velocities of pipes and of sewers at gradients most likely to be used is given in statement A, while longitudinal sections of possible lines of sewers suitable to the lay out proposed by Mr. Lanchester on the 30th July have been plotted from the contours and graded (*vide* plans Nos. VIII, IX and X) ; a study of these profiles with the tables in this statement shews that owing to the small volume of sewage to be dealt with self cleansing sewers will be the exception and flushing must be resorted to largely. This will be expensive in flushing tanks and in size of sewers to obtain a good volume of flush. It is, therefore, necessary to arrange the lay out so far as is possible to get good gradients on the sewers and to arrange the house connections so as to make the best use of the water available. The water for flushing being from a pumped supply must necessarily be expensive. The design of the method of flushing must be considered in connection with that of the irrigation and drinking water supplies, and is one of the points on which the sanitary engineer can usefully be instructed how to deal when preparing the project.

How estimated quantities have been obtained.

4. In order to design a set of sewers from which to obtain quantities for estimating, the distribution of the drinking water supply worked out by Mr. Parker (*vide* appendix C paragraph one of his report in that estimate) has been used to obtain the quantity of sewage each sewer will carry off, the boundaries of the vicinity served by each sewer being marked out on the map (plan No. VI). The discharge calculated as 8 per cent. of the daily drinking water run off in an hour is shown on the longitudinal sections in its appropriate place, but the statement itself being bulky and of no particular importance has been filed. The diagram (plan No VII) will enable the sewers to be readily located, it also gives the capacities and size. The longitudinal sections show the daily water supply allotted to the tract and the pipe running 2/3rds full required to deal with 8 per cent of this in an hour and the pipes selected for estimating purposes. It will be noticed that the pipe required by calculations is usually much smaller than that admissible by good practice ; except where the sewer serves crowded areas such as bazars and clerk's quarters. It does not seem possible in a garden city to avoid having long sewers of small capacity ; in practice the bungalows are likely to be placed as high as possible and the areas for parks on the lower lands.

This is a point that will receive attention in the lay out so that as far as possible the series of sewers that will work well may be designed.

Sewage farm.

5. The sewers follow the nalas as closely as possible and eventually meet near Babarpur village and outfall on to the foreshore below Purana Kila, where a suitable sewage farm can be arranged. By the rule of an acre to 10,000 gallons of daily discharge only 100 acres are needed, whereas it seems certain that several hundred acres of porous soil can be got, *vide* estimate no. 4. Nothing elaborate is provided at the farm, only the lined conduits to distribute the sewage to the land. The improvement and protection of the foreshore, if decided on, will doubtless be a separate estimate; this point is briefly noticed in estimate no 4.

Estimates Nos. 1 to 4.

6. In estimate No. 1 the cost of stone-ware pipes and brick sewers are compared (the latter being cheaper for sizes of pipes 15 inches and over) and per foot run rates worked out to be used in estimate No. 2 for obtaining the probable cost of the stoneware pipes and brick sewers shewn in the plans and sections. The house and other branch sewers being allowed for by a lump sum of about $\frac{3}{8}$ of the probable outlay of those planned and estimated. The excavation has been estimated from the profiles in estimate no. 3 and a rate of Rs. 30 a 100 cubic feet allowed for rock and Rs. 15 for earth excavation: the item is a small one as it is probable that the lay out will be arranged to get easy lines for sewers more or less following the ground.

In estimate no. 4 the sewage farm is estimated at 10,000 lineal feet of distribution conduit at Rs. 3 a foot run this should enable a sufficient area of land to be developed. The cost of land is omitted as it is included in that provided for in the general estimate.

General estimate.

7. The above items are collected in the general estimate and lump sum provisions are made for manholes, lamp-holes, branch pits, syphons, inlets, outlets, catch basins, storm water overflows, ventilation, flushing tanks, sewer outfall, screening chambers and unforeseen items.

There is not likely to be any pumping, but flushing and ventilation are likely to be expensive; the former from the fact that so many lengths of sewers need flushing and that pumped water will be comparatively costly; the latter because there will be few facilities for arranging economical ventilators.

The cost of the sewers.

8. The whole estimate may be arranged as follows :—

	Rs.
Sewers some 35 miles	5,25,000
Manholes etc.	63,000
Syphons, inlets, outlets, catch basins, sewage outfall, screening chambers etc	32,000
Ventilators	50,000
Flushing	1,00,000
Sewage farm	30,000
Unforeseen items	55,000
Total ...	8,55,000

The Khandrat area and that near the city.

9. Since the Okhla navigation cut follows the water parting it will be more economical to run the sewage from the Khandrat that lies to the east of this channel direct to the river while the sewage of some parts of the bazar and clerk's quarters can probably be best dealt with by connecting up with the sewage system of existing Delhi; provision for this is made under unforeseen items. Not unconnected with this subject is the trenching ground west of the Jail which is

considered by sanitary engineers to be unsuitable for building purposes and which should therefore be reserved for a park. In any case it must be closed as a trenching ground almost at once and some other area provided in its place for the needs of the existing city.

The existing sewage farm.

10. The existing sewage farm is on the foreshore immediately down stream of Firoz Shah Kotla. It is probable that this farm must be maintained, as the gradient from the City of Delhi to the outfall below Purana Kila is likely to be too small to transfer the city sewage to the New Capital farm ; if, however, such a sewer is constructed it will be in the interests of the race course that would be admirably placed both for the City and the New Capital on the existing sewage farm : the sanitary engineers will require instructions how to deal with this sewage and with the race course when preparing the project estimate. The provision of Rs. 55,000 for unforeseen items will not cover the expenditure needed to remodel the sewage outfall of existing Delhi should that prove to be feasible and necessary.

House drains.

11. A complete water borne sewage system is a novelty in this part of India, and the amount of detail to be worked out is very great ; unfortunately much of this detail must be thrashed out before the construction of buildings is started as it will be necessary to decide to what extent, if at all, water borne sewage is to be arranged for inside the house : so that the bath rooms may be arranged accordingly. The contoured maps and sections will greatly assist the sanitary engineers to arrive at comparative estimates for different methods of dealing with the problem but it seems probable that, owing to the poor slope to be got in the drains between houses and sewers, bucket depôts will be established and water closets only provided at houses in situations where the fall is very suitable.

The cost of house and compound drains will be met from the estimated cost of buildings and is not provided for in this, nor does it seem necessary to summarise the information collected on this important subject seeing that it can be called for when required.

Programme of work

12. It will not be necessary to push the construction of sewers; they need not necessarily be ready when the first buildings are occupied in October 1915 ; time will be needed to work out the details of the scheme and fit it closely to the city as built with the added advantage that the staff will have more leisure to attend to this somewhat novel construction and the competition for labour will not be so great once the back of the progress on buildings is broken ; the programme may follow that proposed for storm water construction at the end of that report.

Estimated sum to be spent.	1912-13.	1913-14.	1914-15.	1915-16.	1916-17.
Rs.	—	Rs.	Rs.	Rs.	Rs.
8,55,000 ...	Preliminaries in preparing estimate.	1,00,000	4,00,000	3,00,000	55,000

Points needing instructions.

13. The points on which instructions will be required to accelerate the preparation of the project may be summarised as follows—

(*a*) whether the sewage is to be water borne throughout the area.

(*b*) whether a separate or combined system of sewers and storm water drains is to be designed.

(*c*) assuming that the separate system will be adopted, to what extent, if any, the bath rooms etc., of the bungalows will be connected to the sewers.

(*d*) the form of sewage disposal, *i.e.*, whether by farm or any other method.

(*e*) whether the existing sewage farm at Feroz Shah Kotla is to remain or to be removed, and to what extent the cost of this is to be borne by the estimates of the New Capital.

(*f*) the method of ventilating the sewers.

(*g*) the extent to which flushing is needed, and how this should be effected.

(*h*) the extent to which expansion of population is to be provided for in designing the sewers.

(*i*) minor technical points are the alignment of the sewers, the material to be used, the minimum and maximum sizes; these will suggest themselves to a sanitary expert when studying the whole question by the light of the information available. It has, therefore, been thought unnecessary to add more than a few brief details got from the best authorities, these are given in a statement B.

Schedule of rates.

14. A schedule of the rates used in this estimate is added for ready reference, in a statement C.

SEWERS.

General estimate for the complete cost of sewers.

Items.	Particulars.	Amount.
		Rs.
1	29 miles of sewers as in estimate No. 2	3,65,000
2	Small branches etc.	1,35,000
3	Excavation of trench as per estimate No. 3	25,000
4	Manholes, lampholes, and branch pits at 18 to the mile and Rs. 100 each for 35 miles say	63,000
5	Syphons few, if any, likely to be required	2,000
6	Inlets and outlets and catch basins and storm water overflows ...	25,000
7	Pumping not required	*Nil.*
8	Ventilation will not be easy to arrange	50,000
9	Flushing will be largely needed say	1,00,000
10	Sewage outfall and screening chamber	5,000
11	Sewage farm as per estimate No. 4	30,000
...	Unforeseen items	55,000
	Grand total for sewers ...	8,55,000

SEWERS.

Estimate no. 1. Cost of glazed pipes and brick sewers.

Particulars.	Diameter of pipes in inches.											
	9"			12"			15"			18"		
	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.
Cost of pipe	1	2	6	2	0	0	2	12	0	4	12	0
Rail freight	0	6	0	0	10	0	0	13	0	1	4	0
For two feet of pipe ...	1	8	6	2	10	0	3	9	0	6	0	0
Add for breakages, etc. ...	0	8	0	0	14	0	1	4	0	2	0	0
Total ...	2	0	6	3	8	0	4	13	0	8	0	0
Per foot run of pipe (pipes delivered at Delhi.)	1	0	0	1	12	0	2	6	0	4	0	0
Laying and joining ...	0	4	0	0	6	0	0	6	0	1	0	0
Concrete at 30 per 100 c. ft. ...	0	7	0	0	10	0	0	12	0	1	3	0
Earthwork of trench at Rs. 15 per o/oo. c ft.	0	5	6	0	5	9	0	6	0	0	6	6
Total ...	2	0	6	2	1	9	3	2	0	6	9	6
Per foot run say	2	0	0	2	2	0	3	2	0	6	10	0

			Rs.	A.	P.
Cost of a 20" brick sewer *vide* sub estimate No. 1 A.	below		2	10	0
„ 42" „ „ „ 1 B.	below		4	4	0

The cost of small stone ware pipes with pits used in Temporary Works is

for 6 inches ... ... Re. 1-0-0 a lineal foot.

for 4 inches ... ... Re. 0-12-0 „ „

BRICK SEWER NEW SHAPE 20″ × 30″.

Sub Estimate no. 1 A. Quantities of estimate by Sanitary Engineer, United Provinces.

		Rs.
Excavation 292 c. ft. at Rs. 15 per 1000 c. ft. ...	...	4·38
Invert block 26·75 c. ft. at Rs. 88 per 100 c. ft. ...	...	23·54
Brickwork 295 c. ft. at Rs. 40 per 100 c. ft. ...	...	11·80
Concrete 720 c. ft. at Rs. 25 per 100 c. ft. ...	...	180·00
Cement pointing 653 c. ft. at Rs. 5 per 100 c. ft. ...	...	32·65
Setting invert block 100 at Rs. 6 per 100 lineal ft.	...	6·00
Total	...	258·37

or say Rs. 2-10-0 per foot run.

NOTE.—On 1/1,000 grade this running 2/3rds full carries 3·9 cusecs an 18″ pipe running full carries 3·2 cusecs ... ... 234 cubic feet a minute

On 1/1,000 grade this running 2/3rds full carries 2·5 cusecs or ... ... 150 „ „ „

So that it can be used where an 18″ pipe would otherwise serve; it is cheaper than a 15″ pipe and may replace it also.

BRICK SEWERS NEW SHAPE 24″ × 36″.

Sub Estimate no. 1 B. Quantities of estimate by Sanitary Engineer, United Provinces.

		Rs.
Exavation 320 c. ft. at Rs. 15 per 1,000 cubic feet	...	4·8
Invert block 26·75 c. ft. at Rs. 88 per 100 „ „	...	23·54
Brick work 348·5 c. ft. at Rs. 40 per 100 cubic feet	...	139·40
Concrete 845 c. ft. at Rs. 25 per 100 cubic feet ...	...	211·25
Cement pointing 784 s. ft. at Rs. 5 per 100 cubic feet	...	39·20
Setting invert block 100 at Rs. 6 per 100 lineal foot	...	6·00
Total	...	424·19

or say Rs. 4-4-0 per foot run.

	Cusecs.	Cubic feet per minute.
This running 2/3rds full on 1/1,000 grade discharges ...	6·5	390
Whereas a 24″ stoneware pipe running full on 1/1,000 grade discharges	7·1	426
Whereas a 24″ 2/3rds full on 1/1,000 grade discharges ...	5·53	331

This sewer may be used for a 24″ pipe below the junction for the main outfall where 209 cubic feet a minute is indicated.

Estimate no. 2. Cost of stoneware pipes and brick sewers.

Serial letter of sewer.	Name of Sewer.	Pipes.		Brick Sewers.		
		9"	12"	20" (15" pipe.)	20" (18" pipe.)	24" (24" pipe.)
		feet.	feet.	feet.	feet.	feet.
1 R/1 L ...	Salimpur	8,000	...	...	...	...
1 R ...	Safdar Jang	8,000	9,000	...	...	...
2 R/1 L ...	Boring No. 1	5,000	...	...	...	...
2 R/1 L ...	Boring No. 4	8,500	...	...	...	...
2 R ...	Bheron ka mandar	...	11,000	2,000	...	...
4 L ...	Talkatora	5,000	...	...	...	...
3 L ...	Boring No. 2	4,500	...	...	...	...
2 L ...	Raisina	6,500	...	...	...	...
M. S. ...	Main sewer	7,000	4,500	...	6,500	5,500
1 L/1 R ...	Zabta Ganj	5,500	...	...	...	...
1 L/3 L ...	Kalali Bagh	9,000	...	...	...	...
1 L/2 L ...	Paharganj	...	...	13,000	...	...
1 L/1 L (1 R) ...	Khandrat	7,000	...	...	...	...
1 L/1 L ...	Rifle range	9,500	...	...	...	...
1 L ...	Narhaula	8,000	2,500	2,500	2,500	3,500
	Total ...	91,500	27,000	17,500	9,000	9,000
...	These totals = 1,54,000 feet, or say 29 miles.			...		
...	Cost per foot run	Rs. 2/-	Rs. 2/2	Rs. 2/10	Rs. 4/4	Rs. 4/4
...	...... Cost Rs.	1,83,000	57,375	48,125	38,250	38,250
		...	...	...	Total	3,65,000*
...	Add for smaller branches not estimated in detail.		...	...	...	1,35,000
...	Total cost of stoneware pipes and brick sewers.		...	...	...	5,00,000

* This is a rate of Rs. 12,500 per mile.

SEWERS.

Estimate no. 3. Excavation of sewers.

NOTE —The length is measured from the longitudinal sections. The cross sectional area is calculated from the trench with sides lopes of ½ to 1.

I.	II.						III		IV	V
	LIFTS OF 2·5 FEET EACH ABOVE 5 FEET.						TOTAL FOR SEWER.			
Name of sewer.	1st. 5—7·5.	2nd. 7 5—10 0.	3rd 10—12 5.	4th. 12 5—15 0	5th. 15·0—17 5.	6th 17 5—20 0.	Excavation	Rock cutting.	Grand total	REMARKS.
							c ft.	c. ft.	c ft	
Main sewer	6,700	1,550	350	150	50	...	...	...	...	...
	×	×	×	×	×	...	...	...	...	...
	9·25	11·75	13 25	15·75	18 25	...	...	...	...	...
Total ...			88,502 × 2 5				1,50,345	69,910	2,20,255	
Safdar Jang	3,200	2,200	500	200	...	...	...	...	...	...
(1 R)	×	×	×	×	...	...	...	...	...	..
	8 25	10 75	13·25	15 75	.	...	...	...	...	...
Total ...			59,825 × 2 5				1,49,563	...	3,69,318	...
Bhairon ka Mandar	2,500	1,300	500	...	...	...	...	...	...	...
(2 R)	×	×	×	...	...	...	...	...	...	...
	8 25	10 75	13 25	...	...	...	...	...	...	...
Total ..			41,325 × 2 5				1,03,625	...	4,73,443	...
Boring No. 4	450	200	...	...	...	...	...	...	...	...
Sewer (2 R)	×	×	...	...	...	...	...	...	...	...
(1 R)	8·25	10 75	...	...	...	...	...	...	...	...
	37 13	2·150	...	...	...	...		...	...	...
Total ...			5,863 × 2 5				14,658	...	4,88,101	...
Boring No. 1	1,100	...	...	...	...	...	...	...	...	...
(2 R)	×	...	...	...	...	...	...	...	...	...
(1 L)	8·25	...	...	...	...	...	...	...	...	...
Total ...			9,075 × 2 5				22,688	...	5,10,789	.

Talkatora sewer	350	...	...	...	...	...	...	...	...	...
(4 L)	×	...	...	...	...	...	...	...	...	...
	8·25	...	...	...	...	...	...	...	...	...
Total ...			2,818 × 2·5				7,220	...	5,18,009	...
Boring No. 2	1,050	750	300	...	...	...	...	...	...	...
Sewer (3 L)	×	×	...	...	...	...	...	...	...	...
	0 25	10·75	13 25	...	...	...	...	...	...	...
Total ...			20,701 × 2 5				51,753	...	5,69,762	...
Raisina sewer	1,050	475	.275	225	200	150	...	...	...	...
(2 L)	×	×	×	×	×	×	...	...	...	...
	8 25	10·75	13 25	15 75	18 25	20 75	...	...	...	...
Total ...			27,770 × 2 5				69,300	...	6,39,062	...
Narhola sewer	4,000	1,450	1,500	700	300	150	...	...	...	...
(1 L)	×	×	×	×	×	×	.	...	...	...
	8·25	10 75	13·25	15·75	18 25	20 75	...	...	...	...
Total ...			88,076 × 2 5				2,20,190	...	8,59,252	...
Kalah ka Bagh	150	50	...	..	...	...	...	..	...	...
Sewer (1 L)	×	×	...	...	...	...	...	...	...	...
(3 L)	8·25	10·75	...	.	...	...	...	...	...	...
Total ..			1,776 × 2 5				4,440	...	8,63,692	...
Baharganj sewer	3,650	2,700	1,250	600	450	125*	...	..	...	*75 50
(1 L)	×	...	×	×	×	×	...	...	...	...
(2 L)	8·25	10·75	13·25	15 75	18 25	20 75	...	...	...	23·25 25 73
Total ..			98,990 × 2 5				2,47,475	...	11,11,167	...
Khandrat sewer	475	...	..	...	...	...	...	...	...	...
(1 L)	×	...	...	...	...	...	...	...	...	...
1 L (1 R)	8 25	...	...	...	..		...		..	...
Total ...			3,919 × 2·5				...	9 798	11,20,965	...

ESTIMATE No. II (*b*)—SEWERS.

I.	II.						III.		IV.	V.
Name of sewers.	LIFTS OF 2·5 FEET EACH ABOVE 5 FEET.						TOTAL FOR SEWER.		Grand total.	REMARKS.
	1st	2nd.	3rd	4th	5th.	6th	Excavation.	Rock cutting.		
	5—7 5	7 5—10·0.	10—12 5.	12 5—15 0.	15 0—17 5.	17 5—20·0.				
Rifle Range	1,900	950	150	...	...	...	c. ft. ...	c ft ..	c ft ...	...
Sewer (1 L)	×	×	×	...	...	...	..	...	...	...
(1 L)	8 25	10 75	13·25	...	...	...	...	...	...	...
Total ...			27,876×2·5				...	69,690	11,90,655	...
Zabta Ganj sewer	950	...	...	...	...	...	...	...	..	...
(1 L)	×	...	...	...	...	...	...	...	...	...
(1 R)	8 25	...	...	...	...	...	...	...	...	...
Total ...			7,838×2 5				19,595	...	12,10,250	...

The rock from a narrow sewer-cutting is not likely to cover the cost of removal, and the rate may be taken at Rs. 30 per thousand cubic feet, that for earthwork being Rs. 15 per thousand cubic feet.

		Rs.
Say 70,000 cubic feet rock cutting at Rs. 30 per thousand ft. ...	...	2,100
12,10,250 " " excavation at Rs 15 per " " ...	...	18,154
Total	...	20·254*
Add extra for smaller branches, etc.	...	4,746
Total	...	25,000

* This is a rate of about Rs. 700 per mile.

Estimate no. 4. Sewage farm.

Acreage required.

The usual allowance of land for a sewage farm is an acre per 10,000 gallons of sewage per diem so that 100 acres should suffice for the 1,000,000 gallons per diem anticipated in the New Capital.

Area available for a farm.

2. The foreshore of the river between the outfall at Purana Kila and Okhla contains 2,500 acres of which about 1,000 acres within a mile of Okhla is very likely to prove unsuitable as the heading up at the works causes the deposit of a foreshore of small longitudinal slope and having a large admixture of clay making the parts so affected unsuitable for a sewage farm. About 500 acres is on the fan of the Shakarkui Nala and probably lies on an inconvenient slope and the soil is probably too stiff in character, the remaining 1,000 acres is probably very suitable and if so there will be ample area for a farm.

Land.

3. Land is estimated for separately in these reports otherwise 100 acres at Rs 165 an acre or Rs. 16,500 is fairly debitable to this estimate.

River improvement.

4. It is probable that some measures of river improvement may be carried out, but the share debitable to the sewage farm is likely to be small Such improvement works are likely to consist of a revetted earthern embankment with 400 cubic feet of stone per foot run; the whole costing about Rs 2,22,000 a mile; but the whole length of embankment would not need stone protection; the earthwork alone would cost about Rs. 8,000 a mile The four miles from Purana Kila to the weir might cost Rs 5 lakhs, and protect 2,500 acres, if so the cost for 100 acres would be Rs. 20,000, should it be thought necessary to make provision for river improvement this sum may be added.

Buildings.

5 The outlay on the farm to be provided for in the estimate will be on distribution channels and buildings The outlay on the latter, if any at all, will be negligible.

Distributary.

6 The distributary will be a masonry lined open conduit of 20 inch sewer section to carry about 3 5 cusecs on a grade of 1 in 1,250; the velocities at full, half and quarter full will be 1·75, 1·25 and 1·5 respectively; this will cost about Rs. 3 per foot run; allowing for branches and so forth about 10,000 lineal feet at Rs 3 per foot run should be ample

Estimate.

10,000 feet of open masonry conduit of sewer section about 20" broad at Rs. 3 per foot run ... ... Rs. 30,000

STATEMENT A

Table of discharges and velocities of pipes and sewers at gradients most likely to be used.

D—Discharge in cubic feet per second — Sewers. — V—Velocity in feet per second

Size of Sewer.	Gradient. Particulars.	1 in 100. D.	1 in 100. V.	1 in 150 D	1 in 150 V	1 in 200. D.	1 in 200. V.	1 in 250. D	1 in 250. V	1 in 300 D	1 in 300 V.	1 in 400 D.	1 in 400 V.	1 in 500 D.	1 in 500 V.	1 in 750 D.	1 in 750 V.	1 in 1,000. D.	1 in 1,000. V.
9″ diameter ...	Running full ..	1.80	4.07	1.47	3.32	1.27	2.87	1.13	2.57	1.04	2.35	0.90	2.03	0.80	1.82	0.66	1.48	0.57	1.28
Glazed pipe ..	" 2/3 " ...	1.42	4.51	1.16	3.68	1.00	3.16	0.90	2.85	0.82	2.61	0.71	2.25	0.63	2.02	0.52	1.64	0.45	1.42
......	" 1/2 " ..	0.90	4.07	0.73	3.32	0.64	2.87	0.57	2.57	0.52	2.35	0.45	2.03	0.40	1.82	0.33	1.48	0.29	1.28
......	" 1/4 " .	0.25	2.85	0.20	2.38	0.18	2.00	0.16	1.80	0.15	1.65	0.13	1.42	0.11	1.27	0.09	1.04	0.08	0.90
12″ diameter ..	Running full ..	3.87	4.92	3.15	4.02	2.73	3.48	2.45	3.12	2.23	2.83	1.93	2.47	1.73	2.20	1.41	1.80	1.22	1.55
Glazed pipe ...	" 2/3 " ..	3.06	5.45	2.49	4.45	2.16	3.86	1.94	3.46	1.76	3.14	1.52	2.74	1.37	2.44	1.11	2.00	0.96	1.72
......	" 1/2 " ...	1.94	4.92	1.58	4.02	1.37	3.48	1.23	3.12	1.12	2.83	0.97	2.47	0.87	2.20	0.71	1.80	0.61	1.55
.. ...	" 1/4 " ...	0.53	8.45	0.43	2.81	0.38	2.44	0.34	2.18	0.31	1.98	0.27	1.73	0.24	1.54	0.20	1.26	0.17	1.09
15″ diameter ...	Running full ..	7.00	5.72	5.72	4.67	4.95	4.03	4.43	3.62	4.05	3.30	3.50	2.85	3.13	2.55	2.57	2.08	2.22	1.80
Glazed pipe ...	" 2/3 " ..	5.53	6.33	4.51	5.17	3.91	4.47	3.50	4.02	3.20	3.66	2.77	3.16	2.47	2.85	2.03	2.31	1.75	2.00
......	" 1/2 " .	3.50	5.72	2.86	4.67	2.48	4.03	2.22	3.62	2.03	3.30	1.75	2.85	1.37	2.55	1.29	2.08	1.11	1.80
... ..	" 1/4 " ..	0.96	4.01	0.78	3.27	0.69	2.82	0.62	2.53	0.57	2.31	0.49	2.00	0.44	1.79	0.36	1.46	0.31	1.26
18″ diameter ...	Running full ..	11.40	6.45	9.30	5.27	8.05	4.57	7.20	4.08	6.58	3.72	5.70	3.22	5.10	2.84	4.17	2.35	3.60	2.03
Glazed pipe ...	" 2/3 " ..	9.00	7.15	7.34	5.84	6.34	5.07	5.69	4.53	5.20	4.13	4.50	3.57	4.03	3.20	3.29	2.61	2.84	2.25
......	" 1/2 " ..	5.70	6.45	4.65	5.27	4.03	4.57	3.60	4.08	3.29	3.72	2.85	3.22	2.55	2.88	2.09	2.35	1.80	2.03
......	" 1/4 " ..	1.56	4.52	1.27	3.69	1.13	3.20	1.01	2.86	0.92	2.60	0.80	2.25	0.71	2.02	0.58	1.65	0.50	1.42
20″ × 30″ ...	Running full ...	24.35	7.63	19.88	6.23	17.22	5.40	15.40	4.83	14.05	4.40	12.17	3.82	10.88	3.42	8.88	2.78	7.70	2.42
Egg shaped ..	" 2/3 " ..	17.05	8.09	13.92	6.60	12.05	5.72	10.78	5.12	9.84	4.66	8.52	4.05	7.62	3.63	6.22	2.95	5.39	2.57
Brick sewer ...	" 1/2 " ...	10.23	7.25	8.35	5.92	7.23	5.13	6.47	4.59	5.90	4.18	5.11	3.63	4.57	3.25	3.73	2.64	3.23	2.30
......	" 1/4 " ..	2.68	5.34	2.19	4.36	1.89	3.78	1.69	3.38	1.55	3.08	1.34	2.67	1.20	2.39	0.98	1.95	0.85	1.69
22″ × 33″ ...	Running full ..	31.40	8.13	25.63	6.65	22.20	5.75	19.85	5.15	18.12	4.70	15.70	4.07	14.03	3.63	11.47	2.97	9.93	2.57
Egg shaped ...	" 2/3 " ..	21.98	8.62	17.94	7.05	15.54	6.10	13.90	5.46	12.68	4.98	10.99	4.31	9.82	3.85	8.03	3.15	6.95	2.72
Brick sewer ...	" 1/2 " ...	13.19	7.72	10.76	6.32	9.32	5.46	8.34	4.89	7.61	4.46	6.59	3.87	5.89	3.45	4.82	2.82	4.17	2.44
......	" 1/4 " ...	3.45	5.69	2.82	4.66	2.44	4.03	2.18	3.61	1.99	3.29	1.73	2.85	1.54	2.54	1.26	2.08	1.09	1.80
24″ × 36″ ...	Running full ...	39.58	8.62	32.33	7.03	28.00	6.10	25.03	5.45	22.85	4.98	19.80	4.32	17.70	3.85	14.45	3.15	12.52	2.73
Egg shaped ...	" 2/3 " ...	27.71	9.14	22.63	7.45	19.60	6.47	17.52	5.78	16.00	5.28	13.86	4.58	12.39	4.08	10.12	3.34	8.76	2.89
Brick Sewer ...	" 1/2 " ...	16.62	8.19	13.58	6.68	11.76	5.79	10.51	5.18	9.60	4.73	8.32	4.10	7.43	3.66	6.07	2.99	5.26	2.59
......	" 1/4 " ...	4.35	6.03	3.56	4.92	3.08	4.27	2.75	3.82	2.51	3.49	2.18	3.02	1.95	2.70	1.59	2.21	1.38	1.91

STATEMENT B.

Brief notes on technical points to do with sewer design and construction.

Combined or separate system.

1. The combined system is not applicable to India; the rainfall being restricted to about 4 months (average annual at Delhi is 27·7 inches); a dry weather self-cleansing sewer that can cope with monsoon rainfall is beyond the resources of design and therefore a separate system is a *sine qua non.* (James, Oriental Drainage.)

The sewers should follow the drainage lines of towns. (*Ibid.*)

Sewers and drains.

2. Sewers are the conduits built by the public body, drains are those made by the house or land owner.

Sewers.

3. Sewage decomposes more rapidly in India than in England and the capacity of sewers should not be unduly large.

(b) Sewers should not be less than 6″ internal diameter and the tributaries should be smaller than the mains into which they outfall.

(c) Drains for liquids only may be as small as 3″ diameter but any drain receiving the contents of a soil pipe should not be less than 4″.

(d) If rain water off roofs is admitted to house drains 2 inches an hour must be provided for on account of the suddenness of run off. (Moore's Sanitary Engineering.)

(e) In Bombay City with its large supply of 40 gallons a head a day an allowance of six cubic feet of sewage a day, half to flow off in eight hours is made.

(f) Sewers should be designed to run off half the daily water supply in eight hours. (James, Oriental Drainage)

(g) Cast iron pipes are often more economical than stone ware; they can be used under pressure and may therefore be made of smaller diamater: they are becoming increasingly used at home; there is less labour in laying but the first cost is greater.

(h) Depth below ground of sewers is regulated by the area to be drained; the minimum depth over pipes is five feet for wheeled traffic but under pavements twice the diameter of the pipe will do.

(i) The width of trench to be only sufficient for the pipe; a heading may be cheaper when the depth exceeds 16 feet.

(j) Concrete is usual under sewers; 4 inch thick where soil is good; 6 inches where it is not. It should be 12 inches under the pipe and the sides should be haunched up with the material to a height of half the diameter.

Manholes.

4. There should be a manhole at all junctions and bends and 18 to a mile as a rule with lamp holes between pits. Junction pits are needed at all branch pipes and bends.

Gradients.

5. Small sewers require a greater inclination than larger ones, and glazed pipes less than brick drains.

For a	4 inch pipe	a grade of	1-30	is suitable			
„	6 „	„	1-40	„	...	...	...
„	12 to 24	„	1-400 to 1-800		...	...	...
„	Larger pipes	„	less than 1-800		...	...	...

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The minimum velocity should not be less than 2 feet a second for large sewers; in Bombay $3\frac{1}{2}$ feet is usually the minimum as Indian sewage has much sand and broken pottery in it; for the same reason, and on account of the hardness of the road material carried in, five feet is the maximum.

STATEMENT C.

Schedule of rates used in this estimate.

			Rs.		
Earthwork in trenches	...	...	15	%o	cubic feet
Rock cutting „	...	...	30	„	„
Concrete under pipes or in sewers		...	30	%	„
„ in brick sewers	...	...	25	„	„
Brick work „	...	...	40	„	„
Cement plaster ...	...	...	5	„	sq. feet.
Invert blocks ...	...	...	88	„	cubic feet.
Laying invert blocks	...	...	6	„	lineal feet.

	R.	a.				
4″ stoneware pipes laid	0	12	a foot run			
6″ „	1	0	„	...	...	...
9″ „	2	2	„	...	...	...
12″ „	2	2	„	...	...	...
15″ „	3	2	„	...	...	...
18″ „	6	10	„	...	...	...
20 inch brick sewer	2	10	„	...	...	...
24 „ „ „	4	4	„	...	...	...
20 inch sewage farm distributary	3	0	„	...	...	...

The sewers, estimated, work out to Rs. 12,500 per mile.

Area of sewage farm 100 acres per 1,000,000 gallons of daily flow.

Stone revetting required on the Jumna 400 cubic feet per foot run.

Report dated 27th September 1912 by Mr. H. E. Parker, assistant sanitary engineer to the Government of the United Provinces, on the cost of a Sanitary Installation.

LIST OF CONTENTS.

Report dated 27th September 1912 by Mr. H. E. Parker, assistant sanitary engineer to United Provinces Government, on the cost of a Sanitary Installation.

1. *Scope.*—This estimate is to cover the provision for installing sanitary plant for refuse disposal, road watering, bazaar latrines and bathing and washing places, it will not deal with the sewage disposal or the storm water drainage or water supply, which are dealt with under separate estimates.

2. *Refuse disposal.*—The quantity of refuse to be disposed of is a point on which we have, at present, no definite information.

Moore in his book on sanitary engineering gives the average quantity for London in 1895 as 260 tons per annum per 1,000 people; but this figure is hardly applicable to the case of the new capital, as in London the population is very much more concentrated and there is a very much larger consumption of fuel and consequently a larger residue of ashes than will be the case in Delhi ; on the other hand there will be a larger quantity of garden refuse to be provided for.

The quantity of dry rubbish carted daily from the Delhi city, not including the suburbs is 24 tons, *i.e.*, 8,760 tons, or say 9,000 tons per annum. The population of Delhi according to the census returns of 1911 is 2,32,837 say 2,33,000 of which about 86,000 live in the suburbs of Sadr Bazar, Sabzi Mandi, Paharganj, etc., leaving a population within the city walls of 1,47,000.

The quantity of refuse per annum, therefore, works out at 61¼ tons per 1,000 people per annum, say 60 tons per 1,000 per annum.

The area of the city within the walls is 1,450 acres, so that the density of population is 101½, say 100 per acre, and the quantity of refuse removed is just over 6 tons per acre per annum.

The above figures will hardly be applicable to the new capital as the quantity of refuse per 1,000 people will probably be larger on account of garden and stable refuse and the quantity per acre will be less on account of the density of population per acre being lower. The density of population in the water supply scheme and the acreage of the different classes of suburbs varies from 150 per acre in the peons' quarters and 97 in the bazaars to 1½ per acre over the area allotted to the University and about 10 per acre for the officials' bungalows. I propose to estimate the refuse to be disposed as follows :—

(1) a certain acreage of each compound will be taken as being populated with 25 per acre, and the refuse from this area will be calculated at the rate per 1,000 population, the remainder of the area of compounds will be taken at the acreage rate ; this will apply to the officials' bungalows, Indian chiefs, and the higher paid clerks, and shop keepers.

(2) In the case of the lower paid clerks I propose to take the whole of the area as being inhabited.

(3) The bazaars will be taken at the same rate per 1,000 population as in the city.

(4) Peons' quarters at 50 % above the figures for the city, as this area is more densely populated.

(5) Markets, veterinary hospital, municipal cattle, etc., at double the acreage rates.

(6) Gardens and parks will be taken as disposing of their own refuse locally.

(7) Secretariats and "*place*" in front of Government House at ½ the acreage rates.

With the above assumptions the dry refuse to be removed from the city works out at (see Appendix A) 408 tons, say 400 tons per annum per 1,000 people, or $2\frac{3}{4}$ tons per acre of the new capital excluding outside parks. The figures used in these calculations for the quantity of refuse are :—

The population is, as shown in the estimate for water supply, namely, 5,000 europeans and 40,000 indians, and the area is that shown in the schedule of areas, namely, $5,369\frac{1}{2}$ acres, excluding roads and outside parks, but allowing for the area of roads by adding 25 % to the above it works out at 6,712 acres.

For estimating the number of carts required and capacity of refuse destructors I am assuming that the maximum amount of refuse to be disposed of in any one day will be double the average quantity and that the number of carts which should be provided in excess to allow for break down should be 20 per cent.

The average daily quantity of refuse has been shown to be 50 tons per day, it is assumed that the maximum quantity in any one day may amount to 100 tons.

The capacity of a dry refuse cart is 30 c. ft or $4\frac{1}{2}$ maunds of rubbish, therefore to deal with the weight of rubbish it will be necessary to provide for 2,800 cart loads per day.

The site proposed for the disposal works is at Indraput about 3 miles from the central parts of the new capital and the carts will have to do approximately double this distance per journey, once in collecting refuse and carrying it to the disposal works and the 2nd time in returning to their collecting grounds. The daily journey for a bullock may be taken as 12 miles, therefore it may be assumed that those carts which have to collect from beyond the centre of the city will only be able to make one journey per day, while those within the 3 mile limit from the disposal works will be able to average two journeys per day.

The number of carts required will therefore be :—

	1,400	at one journey per day
	700	„ two „ „
Total	2,100	

Add 20 % to cover the number laid up for repairs, total number required 2,500.

The list price of a refuse cart is Rs 150 therefore the cost of refuse carts for dealing with the refuse of the new capital will be Rs. 3,75,000 not including the cost of bullocks.

I propose to dispose of the refuse collected from the new capital in a refuse destructor, situated near Indraput at the site of the irrigation pumping station and to utilise any heat generated in the destructor to assist in generating steam for driving the irrigation plant.

During nine months in the year it may be possible to materially assist in steam production for the pumping plant, but during the monsoon period the refuse will frequently be saturated with water and all the heat generated will be required for drying the refuse before dumping it into the destructors; during this period however the irrigation works will probably be at a standstill, as water will only occasionally be required.

It may be necessary to add a small amount of coal or ashes to the refuse, in order to assist in its destruction, as the greater part of it will probably be vegetable matter.

The value of London refuse as fuel is said to be from $\frac{1}{5}$ to $\frac{1}{10}$ of that of good coal, but this refuse is largely composed of cinders and ashes, which would be practically entirely absent from the refuse we are dealing with.

The amount of refuse which can be disposed of by destructors with forced draught is about 5 to 10 cwts. per hour per cell, the grate area varying from 24 to 39 square feet, *i.e.*, about $\frac{1}{4}$ cwt. per square foot of grate area per hour.

Therefore to consume 100 tons of refuse per 24 hours we will require destructors with grate areas aggregating to 334 s. ft. say 10 cells each with a grate area of 33·5 s. ft.

Allow a lump sum to cover the cost of the above Rs. 1,00,000.

Latrine accommodation in Bazaars.

3. *Latrines.*—The United Provinces Factory Act provides for latrine accommodation at the following rates—

2 seats for 50 people.

3 " " 100 "

4 " " 150 "

5 " " 200 "

above 200, 1 seat for each 50 people or fraction of 50. James, in his book on Oriental Drainage, allows 5 seats latrine accommodation per 100 people for dry pattern latrines, and 2 seats per 100 for water flushed latrines.

In the new capital area all residences will be provided with latrines for their own servants, and the only places which should be provided with latrines in this estimate are the secretariats and other offices, peons' quarters, bazaars, and menial quarters, etc. Latrines for the police will be provided in their own lines and therefore are not included here.

In the secretariats latrine accommodation should be provided for 2,859 clerks and 2,000 peons, 97 seats say 100, in the administrative offices for 55 clerks and say 25 peons, 3 seats, say 5, (3 for clerks, 2 for peons) ; in the peons' quarters for 6,000 men and women, 120 seats, and in the bazaars and menial quarters for 13,000 people, 260 seats. Total 484, say 500 seats.

The estimated cost of a 48 seated water flushed latrine at Benares was Rs. 5,333 or about Rs. 112 per seat and for a single seated water flushed latrine at Cawnpore Rs. 350.

The blocks of latrines will probably never be as large as 48 seats, and there may be a few single or double seated ones, which as has been shown cost more per seat than the large blocks, I therefore propose to adopt an all round rate in this estimate of Rs. 200 per seat. 500 latrine seats at Rs. 200 each = Rs. 1,00,000.

4. *Road watering.*—The lengths and widths of the various roads in the new capital are as follows :—

Width over all.	Length.	Width of metal.	Area.
Ft.	Ft.	Ft.	S. Ft.
200	43,200	70	3,024,000
80	47,800	32	1,529,600
60	148,500	32	4,752,000
50	158,400	24	3,801,600
40	52,800	20	1,056,000
12	158,400	9	1,425,600
	609,100 = $115\frac{1}{2}$ miles say 120		15,588,800

The area of roads to be watered is therefore 15,588,800 s. ft. I have included the area of service roads as requiring watering, as even if certain of the main and side roads are tar macadammed, or otherwise treated to prevent dust, it is unlikely that the service roads will be so treated and they will consequently give off dust, unless they are regularly watered Assuming that the width of road covered by an ordinary water cart per journey is 10 ft., therefore the lengths of travel of the carts will be—

				Ft.
200 feet roads	...	...	... 43,200 × 7	= 302,400
80 " "	...	...	... 47,800 × 3	= 143,400
60 " "	...	...	... 148,500 × 3	= 445,500
50 " "	...	...	... 158,400 × 3	= 475,200
40 " "	...	...	... 52,800 × 2	= 105,600
12 " "	...	...	... 158,400	= 158,400
		Total	...	1,630,500
				=309 miles say 300 miles.

Taking the depth of water required per day on roads as $\frac{1}{8}''$ the quantity required on the area will be about 1,000,000 gallons. It is assumed that the hydrants from which the water carts will be filled will be economically arranged, so spaced that the distance between them is equal to the travel of a cart between fillings, assuming the rate of progress of a bullock at 2 miles per hour, and that all watering is to be done in 2 hours, the number of carts required to cover the distance will be 75 carts. Say 100.

This will however be insufficient, as this number means that if the capacity of each cart is 100 gallons each cart has to be filled 100 times per day and if 2 minutes only is taken per filling 3 hours would be taken in filling them.

Allow 200 carts at Rs. 185 each = Rs. 37,000.

It will probably be found advantageous to adopt motor carts for collection of dry rubbish and for road watering but this is a point which can be settled later on, as both these items come, in my opinion, more properly under the administration of the city after it is built. Fire engines, steam rollers, bullocks for drawing rubbish and water carts should also be included under administration.

5. *Urinals, bathing places and dhobi ghats.*—With the outlay on latrines that on urinals is likely to be small while the proximity of the river will relieve the demand for bathing places and dhobi ghats till some years after the new capital is inhabited, so that a lump sum provision of Rs. 18,000 is likely to be ample under this sub-head.

6. *The estimate.*—The cost of a sanitary installation of rubbish carts, incinerators, latrines, water carts, urinals and dhobi ghats is likely to cost the following sums :—

		Rs.
Dry rubbish carts	... ...	3,75,000
Incinerators	... ...	1,00,000
Latrines	... ...	1,00,000
Water carts	... ...	37,000
Urinals, washing places and dhobi ghats	... ...	18,000
	Total ...	6,30,000

7. *Programme of work.*—The buildings in the new capital are to be built at the following rates :—

$\frac{1}{4}$ in 1913 to 14.

$\frac{1}{2}$ in 1914 to 15.

$\frac{1}{8}$ in 1915 to 16.

$\frac{1}{16}$ in 1916 to 17.

$\frac{1}{16}$ in 1917 to 18.

There will be large cooly camps on the area, and the refuse from these has to be disposed of, but this matter is a point which should be dealt with by the contractors or by the sanitary officer in charge of the camp, and should not be included in this estimate though it may be economical to use the carts as they are provided. The latrine accommodation will only be required as the houses are built and occupied and consequently will be estimated at the same rate of progress as the buildings.

I propose to erect the incinerators in 3 instalments, 4 cells during 1913-14, 4 cells in 1914-15, and 2 cells in 1916-17.

Rates of expenditure.

—	1912-13.	1913-14.	1914-15.	1915-16.	1916-17.	1917-18.	Total.
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Refuse carts ...	...	93,750	1,87,500	46,875	23,438	23,437	3,75,000
Incinerators ...	...	40,000	40,000	...	20,000	...	1,00,000
Latrines	...	25,000	50,000	12,500	6,250	6,250	1,00,000
Water carts ...	...	9,250	18,500	4,625	2,312	2,313	37,000
Urinals, bathing places and dhobi ghats.	...	...	...	6,000	6,000	6,000	18,000
Total ...	...	1,68,000	2,96,000	70,000	58,000	38,000	6,30,000

Of the above the whole of the cost of refuse carts and water carts is for materials which could be purchased in England, in the case of the incinerators roughly, say, $\frac{3}{5}$ would be located to England, and in that of the latrines about 50 to 60 per cent. *i.e.*

—	1913-14.	1914-15.	1915-16.	1916-17.	1917-18.	Total.
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
In England	1,42,500	2,58,000	57,750	42,000	28,750	5,29,000
In India	25,500	38,000	12,250	16,000	9,250	1,01,000
Total ...	1,68,000	2,96,000	70,000	58,000	38,000	6,30,000

8. *Points needing instructions.*—Points on which instructions are required for those preparing the project.

Whether provision for the installations need be made against the project estimate of the new capital. If the provision is to be made the extent to which new and up to date methods of refuse collection, incinerators, latrines, watering carts etc., are to be availed of.

9. *Schedule of rates.*—A schedule of rates used in this estimate is attached in Appendix B. for facility of reference.

APPENDIX A.

REFUSE DISPOSAL.

Estimate of quantity of refuse to be dealt with.

No.	Description.	Population.	Acreage.	Acres populated at 60 tons per 1,000 people.	Acres unpopulated at 6 per acre.	Refuse per annum.		Total.
						Tons.	Tons.	Tons.
...	Government House say	1,200	311	48	263	72'0	1,578	1,650
...	Commander-in-Chief	234	63½	9½	54	14'0	324	338
6	Members of Council	324	36	13	23	19'5	138	157'5
4	Railway Board and Bishop	216	20	8½	11½	13'0	69	82
35	Secretaries	1,190	175	48	127	71'5	762	833'5
43	Deputy Secretaries	1,462	172	58½	113½	87'5	681	768
133	Under Secretaries	3,857	399	154½	244½	231'5	1,467	1,698'5
107	Registrars	1,498	149	60	89	90'5	534	624'5
108	1st class Clerks	324	108	13	95	19'5	570	589'5
2	European gardeners	16	Included in	gardens and parks	...	...	...	...
1	Bishop's chaplain	23	"	" "	...	...	...	...
16	Administrative officers	448	48	18	30	27	180	207
...	Spare sites	350	35	14	21	21	126	147
...	Club	200	67½	8	59½	12'0	357	369
75	Indian chiefs	1,200	498	80	418	72'0	2,528	2,600
400	Indian Raises	1,000	390	40	350	60'0	2,100	2,160
...	Hotels	1,350	38	say 38	...	81'0	...	81
...	Shopkeepers	1,000	146	40	106	60'0	636	696

...	Medical schools	200	30	say 10	20	12'0	120	132
...	University	400	275	15	260	24'0	1,560	1,584
...	Officials residences	3,190	110	110	...	191'5	...	191'5
451	European clerks	1,353	246	246	...	81	...	81
620	Indian clerks	1,860	360	360	...	111'5	...	111'5
1782	Clerks under Rs. 100	5,346	178	178	...	321'0	...	321
...	Bazaars	13,000	135	135	...	780	...	780
1943	Peons quarters	5,829	39	39	...	349'5	...	349'5
...	Theatre	...	2	...	1	...	6	6
...	Tennis grounds	...	15	...	7½	...	45	45
...	European and Indian club	...	5	...	2½	...	15	15
...	Race course	...	...	...	...	...	...	...
...	Golf course	...	334	...	...	...	...	...
...	Polo grounds	...	46	...	...	...	...	...
...	First class shops	...	18	...	...	...	...	...
...	Cemeteries	...	96	...	...	...	...	...
...	Orphanage	...	25	...	12½	...	75	75
...	Dispensary	...	3	...	1½	...	9	9
...	Schools	...	32	...	32	...	192	192
...	Churches	...	9	...	4½	...	27	27
...	Oriental research institute	...	70	...	...	...	...	...
...	Secretariat Parks	...	129	...	...	...	...	...
...	Secretariats	...	169	...	84½	...	507	507
...	*Place* in front of Government House	...	108	...	54	...	324	324
...	Safdar Jang Park	...	115	...	...	...	...	...
...	Lodi Tomb Park	...	144	...	...	...	...	...
	Carried over ...	47,075	5,349	1,744	2,485	2,822'5	14,930	17,752'5

Estimate No. II (*c*)—Sanitary installation.

No.	Description.	Population.	Acerage.	Acres populated at 60 tons per 1,000 people.	Acres unpopulated at 6 per acre.	Refuse per annum.		Total.
						Tons.	Tons.	Tons.
	Brought forward ...	47,075	5,349	1,744	2,485	2,822·5	14,930	17,752·5
...	Jantar Mantar Park	...	21	...	...	...	...	...
...	Delhi City Park	...	407	...	...	...	...	...
...	Markets	...	10	...	20	...	120	120
...	Veterinary hospital	...	6	...	12	...	72	72
...	Post office	...	2	...	1	...	6	6
...	Police station	...	2	...	2	...	12	12
...	Vegetable market	...	10	...	20	...	120	120
...	Municipal cattle	...	10	...	20	...	120	120
...	Dairy farm	...	30	...	...	...	...	...
...	Town Hall	...	2	...	1	...	6	6
...	Municipal menials	...	15	...	15	...	90	90
...	Conservancy depôt	...	12	...	...	...	...	...
...	Slaughter house	...	...	...	...	...	say 50	50
...	Junior officials	...	5	...	5	...	30	30
	Total ...	47,075	5,881	1,744	2,581	2,822·5	15,556	18,378

18,378 tons per annum.

Say 50 tons per day.

APPENDIX B.

Schedule of rates used in this estimate.

Dry refuse carts	Rs. 150 each.
Road watering carts	„ 185 „
Latrines	„ 200 per seat.

Lump sum items.

Incinerators	Rs. 1,00,000
Urinals, bathing places and dhobi ghats	„ 18,000

Quantity of dry refuse 400 tons per 1,000 people per annum.

2¾ tons per acre per annum.

50 tons per day (average).

100 tons per day (maximum).

Capacity of dry refuse cart 30 c. ft. or 4½ maun.

Refuse destructors ½ cwt. per sq. ft. grate area per day.

Latrines 2 seats per 50 people.

3 seats per 100 „

4 seats per 150 „

5 seats per 200 „

above 200, 1 seat per 50 or fraction thereof.

Road watering ⅛" depth of water per day.

Travel of a bullock cart 12 miles per diem.

Duration of road watering 2 hours per diem.

G. C. B. P., Simla,—No. 708 H. D.—15-11-12.—55.—M.D.D.

ESTIMATE No. III.

Irrigation ... ... Rs. 41,54,887

708HD

ESTIMATE No. III—IRRIGATION.

Report dated the 22nd July, 1912, by Lieutenant G. E. Sopwith, R.E., on the cost of irrigating the site of the New Capital.

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APPENDICES.

DIAGRAMS.

NOTE.—Diagram No. 1 is in a separate cover. Diagrams Nos. 2 and 3 are in the body of the report.

Report dated 22nd July, 1912, by Lieutenant G. E. Sopwith, R. E., on the cost of irrigating the site of the New Capital.

1. Preliminary.

In a previous note dated 18th April, 1912, a rough estimate of the cost of irrigating the Malcha site was given. At that time the site had not been definitely fixed, nor had any lay out of roads, avenues, and parks been attempted, so that the estimate was necessarily of a general description. A tentative lay out has now been made and is shown on the accompanying plan on a scale of 4″ to 1 mile. This has enabled the present note to be written, which aims at giving a nearer approximation of the probable cost of the irrigation of the New Capital. It must be understood, however, that owing to the lay out shown being a tentative one, absolute accuracy of calculation is impossible at the moment, and several approximations have had to be made.

In considering the problem, it has been considered sufficient to divide up the area into two portions (Division line shown as * * * on the map), to calculate the requirements of one-half, and to assume that double these requirements will suffice for the whole area.

2. Alternative sources from which water for irrigating the area might be obtained.

The following sources, from which water for irrigation might be obtained exist :—

(1) The Western Jumna canal.

(2) The river Jumna.

(3) The subsoil water.

3. Advantages and disadvantages of the various sources.

(1) As explained in the previous note the Western Jumna canal remains closed during a portion of each month in times of high demand, but equally serious closures from the point of view of a garden city are those that occur when the demand disappears on the advent of copious rains, and examination of the records for the last 20 years shows that such a closure* might last for 52 days. Storage would therefore be necessary, if this source were utilised and, as the requirements of the area amount to some 20,000,000 gallons per diem, a storage for even one month, would amount to 600,000,000 gallons or about 100,000,000 cubic feet.

It should be stated that the canal may only flow for 10 days at a time, so that the supply for 10 days plus storage for a month would amount to Rs. 130,000,000 cubic feet and this amount delivered in 10 days is at the rate of 150 cusecs. The Delhi branch has also to carry the irrigation requirements of the area north of Delhi amounting to some 50 cusecs more or a total of 200 cusecs. Considerable expense would be incurred in remodelling the branch to enable so large a supply to flow and as the bed slope of the last 12 miles of the branch is *nil*, the pumping of so large a quantity at such a rate would reduce the level of the canal water at Delhi itself to such an extent as to render irrigation by flow over much of the northern area impossible. Again, supposing that a supply sufficient for the New Capital was always maintained in the branch, experience shows that something like 100 cusecs would have to enter the head of the branch to allow of 30 cusecs reaching the tail, and in years of high demand, 100 cusecs represent 15,000 acres of irrigation and the cultivators would be deprived of that amount of irrigation, a serious matter in times of famine.

The difficulties involved in thus sending down a much smaller supply than the normal full supply of the branch are also great, as great trouble would be caused by accumulation of silt and the growth of weeds and grass on the bed, side slopes and berms.

The limits of irrigation by flow may be taken as the line of the 700 contour, and a reference to the map will show that the land below this level represents only a small fraction of the whole area, and does not include such important

* These records are filed in the office and are two voluminous to be attached as an appendix.

portions as the viceregal park, or the compounds of the most important of the inhabitants. To reach these portions of the area pumping would have to be resorted to.

2. The river Jumna is the source from which the Western Jumna canal, the Eastern Jumna canal north of Delhi, the present drinking water-supply at Delhi and the Agra canal below Delhi take their water. Pumping would be essential, if this source were adopted as the low water level of the river is R. L. 657 at Indarpat.

Before adopting this source the question whether the water in the river is sufficient for the requirements of the irrigation of the New Capital must be considered. During the cold weather months, when the discharge of the river, where it debouches from the hills, is falling, and when demand is normally high, the whole water of the river is taken by the Western and Eastern Jumna canals at their heads at Tajawala, and immediately below the weir the river bed is dry. Water however percolates from the canals, and part of it finds its way back through the subsoil into the river. Possibly also the water, which flows beneath the bed of the river, may spring up lower down, but, as the slope of the bed is very small (only 15" in a mile at Delhi) it is more probable that the flow is parallel to the bed and does not spring up at all, so that the cold weather supply, unless the canals are closed, is probably entirely dependent on percolation from the east and west.

A diagram has been prepared and attached as Appendix A. which shows that some point exists between Panipat (junction of main drain No. II) and Delhi, from which southwards the rate of increase of inflow per mile decreases and in years of meagre rainfall even ceases altogether, *i.e.*, the water received by percolation north of this point actually percolates back in the subsoil south of this point.

It will be noticed in the diagram for the years 1906-07 that the rate of increase of flow increases up till some date in the first half of December, thereafter decreasing. The explanation of this is that there was a very heavy monsoon in 1906 in the hills, and the normal rainfall was very greatly exceeded. It would therefore appear probable, that, except after a succession of heavy monsoons, the percolation into the river south of the point between Panipat and Delhi is either very slight or is a minus quantity. Panipat being situated, in relation to the canal, in a position, which water for two branches of the canal passes, the total quantity of water in the canal affecting the subsoil at Panipat is very much greater than the total quantity passing down the Delhi branch alone, which branch is the determining factor in considering the percolation into the subsoil near Delhi. This would account for the difference in rate of increase of inflow except in years of exceptional rainfall when the percolation of rainwater back into the Jumna is so great for a time as to affect the normal conditions due to the percolation of canal water.

Actual observations of discharges of the Jumna have been made this year, and are attached as Appendix B. It will be seen that on July 4th the actual observed discharge was 64 cusecs only, which is the lowest on record, and this quantity is only just over twice the estimated initial requirements for the irrigation of the New Capital. It may conceivably be supposed that the future requirements may greatly exceed the initial ones, and, if the supply in the Jumna were to fall below the present discharge, a time might come when the flow would be insufficient for the irrigation requirements. It should be remembered that so small a discharge of the river implies that there is no rain, as otherwise the canals would probably be entirely or partially closed, thus releasing water into the river, and that such times would be exactly the ones, when the demand in the New Capital would be at a maximum.

As to whether the flow is likely to decrease or even to cease in exceptional circumstances is one that it is difficult to dogmatise on. The main line of the Western Jumna canal, and its Delhi branch run along the watershed of the country, the other two branches running towards the west. It may therefore be presumed that something like half the water percolating from the main line and the Delhi branch flows towards the west and so into the natural drainage in that

direction and is thus lost altogether to the Jumna, while the whole of the water percolating from the Sirsa and Hansi branches may conceivably be also running towards the west. We know, that, when the Sirsa branch was fully developed in 1896, the water table near Delhi sank 10 feet and has never since risen to its former level, and there seems no reason to suppose that this loss of water, due to the transference of a considerable percentage of total canal discharge from the Delhi to the Sirsa branch, water which originally found its way back into the Jumna, being on the Jumna side of the watershed is compensated for, as far as the Jumna is concerned, by equivalent percolation into the Jumna at a point further north since the loss of water now takes place wholly on the western slope of the watershed, and therefore probably flows through the subsoil in a westerly direction.

As the efficiency of cultivation increases (it is probably nearly at a maximum now on the Western Jumna canal system) the area irrigated increases, the depth of waterings is more economical, and consequently less percolates into the subsoil, evaporation and transpiration of the crops accounting for the water spread over the ground.

It would therefore appear that the tendency is for the subsoil flow back into the Jumna bed to decrease, and, if this source is adopted, it may be necessary to ensure the required supply by compensation from the canal system by opening escapes. This would be a costly method and one, that might endanger the maturing of crops in certain localities but it must be borne in mind as a possible necessity, should the present low discharges of the river decrease still further or fall to vanishing point.

(3) Pumping from the subsoil water is the third alternative. Careful study of the conditions of the subsoil water in the area is being made but it is doubtful whether the subsoil water would stand the strain of such a large quantity of water being pumped from it, seeing that the ridge is so close to the river, is very bare, which would involve a large percentage of rain water running off by natural nallahs instead of percolating into the subsoil, and that the catchment area is so small. Moreover we know that in years of light or normal rainfall water is actually percolating into the subsoil from the river, and, even if such percolation supplied the quantity required for irrigation, the water level would be considerably lower than that of the river which would involve a greater head and consequently a large increase in cost of pumping, which, being recurring expenditure, is one of the most important items to aim at economy in.

4. Points involved in the various systems of internal distribution of irrigation water.

There are four methods of internal distribution, *viz.*:—

(1) Flow irrigation in open channels.

(2) Lift irrigation and distribution in open channnels.

(3) A combination of flow and lift irrigation.

(4) Pumping and distribution by pipes.

(1) Flow irrigation in open channels is the method ordinarily adopted in irrigating land, and is of course, infinitely the cheapest, as no power is required at all. It has the disadvantage that it is difficult to control the water in such a way as to prevent needless waste. Distribution in open earthen channels involves a great number of culverts, syphons and similar works to allow the crossing of roads, paths, etc., and this is expensive. The percolation into the subsoil, amounting to 6 cusecs or so per 1,000,000 square feet of water surface, has a great influence on the subsoil, and in many places actual waterlogging has taken place from this cause. To avoid this as far as possible canals are designed to follow ridges, but the positions of compounds houses, etc., in the New Capital may easily prevent this desideratum being worked to as extensively as is desirable. It is not known definitely at the moment, though investigation in this direction is being carried out, what are the conditions of permeability of the subsoil in the area, but there is reason to suppose, from the soil being a fairly compact loam, that the subsoil drainage is somewhat slow. It is therefore essential to minimise the percolation into the subsoil to a practically infinitesimal

quantity, lest the area become as waterlogged as is the Durbar area, the present condition of which was one of the principal reasons for abandoning that area as a site for the New Capital.*

* Assuming there to be some 200 miles of open earthen channels in the New Capital and the average water surface to be 2 feet the loss by percolation would be $\frac{200 \times 5,280 \times 2 \times 6}{1,000,000}$ or over 12½ cusecs, *i.e.*, half the supply.

It has also been noted that the area, which could be irrigated by flow, is only a small portion, and that the less important portion of the whole site.

The substitution of masonry channels for earthen ones would prevent to a large extent any percolation into the subsoil, but this would be expensive.

A further argument against using the open channels at all, whether masonry lined (pacca) or earthen (katcha), is that it is a certainty that large quantities of water would go to waste, and consequently the 25 cusecs, which is actually required for use in the gardens of the New Capital could only be obtained by the users, if a very much larger quantity were supplied, so as to allow for the waste. During the Durbar preparations only some 20 per cent of the water actually supplied was usefully employed, the remainder disappearing by percolation and waste at the outfalls of the channels.

As already stated in times of great demand the canal runs for only 10 days in the month and the storage to enable a continuous flow in the distribution channels would be so large as to be impracticable, both on the score of expense and also in view of the area that such storage would occupy, and for which there seems no suitable site. The depth of any such reservoir would be very small, otherwise the area commanded would be very greatly decreased, and the evaporation from such a reservoir would be considerable.

(1) Flow irrigation direct from the Western Jumna canal, and in times of closure, from a reservoir seems therefore to be out of the range of practical engineering, as also distribution in open channels whether masonry lined (pacca) or earthen (katcha).

(2) Lift irrigation and distribution by open channels involves the same principles as (1) whether the lifting is done direct from the river, or from the storage reservoir filled by the Western Jumna canal.

(3) A combination of flow and lift irrigation supposes the irrigation by flow of such portion of the area as is commanded, and the irrigation by pumping from the river of the remaining portion, and also of the commanded area during times of closure.

This, for the arguments already used, is not practicable, as the flow irrigation would have to be in open channels the loss of head in pipes, if used, being greater than the available head, unless pipes of altogether prohibitive size were used, while the cost of the varying power required to pump the supply, according to whether the canal was closed or open would probably equal the cost of continuous pumping of a sufficient supply to serve the whole area continuously.

(4) Pumping and distribution by pipes involves pumping from the river, or from the canal with a storage reservoir to draw on during closures. Such storage reservoir would be, as already pointed out, enormous and does not appear practicable. It would, therefore, appear better to pump direct from the river, and possibly also, as a subsidiary source, from the effluent water of the sewage outfall, provided there were no sanitary objections to such a course.

A distribution by pipes has the following advantages :—

(1) The control of each portion of the supply is at the tail, *i.e.*, it can be controlled in each compound or other area by merely turning on or off the stopcock, a very different thing from control at the head, which is the only method in flow irrigation, and which, in the case of a city, must inevitably lead to waste, for when one owner has taken his water, he closes the outlet, and if the owners below him do not want water at that particular moment the water flows uselessly on to the outfall, whereas, on the turning off of a stopcock the water remains in the pipe until some other stopcock is turned on.

(2) Percolation is *nil*, and there is thus no fear of raising the subsoil water level, except by overflooding of parks and gardens, a fault which can be checked with ease and certainty by the introduction of meters at each area connection, and charging for water by meter rates.

5. The most advantageous method of irrigation.

From the arguments previously advanced, it would appear that pumping from the river Jumna and distribution by pipes is undoubtedly the most practical method of irrigating the New Capital, and this note will now deal with the practical problems involved in carrying out this method and its probable cost.

6. Area to be protected by irrigation.

According to the latest details of the areas required for parks, roads, avenues and compounds, the area to be protected is 9 square miles, and to this may be added 3 square miles to allow for extensions, making in all an area of 12 square miles. This area corresponds with the area of the lay out, shown on the map.

This excludes the cantonment area, and also does not allow for the watering of the trees on the ridge, both of which must be treated as separate items to be allowed for by combination with the drinking water supply or by separate pumping systems. The object in excluding them from the New Capital system is to avoid the extra lift necessary to get water to these areas, as it is proposed to pump water up to R. L. 760 for the New Capital while the water for the cantonment must be delivered at R. L. 775 (with a lift over the Ridge which is over R. L. 800) and water for the trees must be delivered at the highest part of the Ridge R. L. 865.

7. Total Supply of water required to protect 12 square miles.

A reference to paragraphs 4, 5 and 6 of the previous note* will show that, making due allowance for the different quantities of water required per acre of gardens, lawn or road respectively. A supply of ·0116 cusecs is required to protect 4 acres.

Therefore the supply required to protect 12 square miles is—

$$\frac{12 \times 640}{4} \times \cdot 0116 \text{ cusecs.}$$

$$= 22\tfrac{1}{4} \text{ cusecs, say } 23 \text{ cusecs.}$$

To allow for possible extensions of park (only 1,000 acres have been allowed for) and also for flushing drains, etc., it will be advisable to assume a requirement of 25 cusecs.

8. Lay out of pipe line for the purposes of this estimate.

It is proposed to pump direct from the river near Indarpat by a double 33″ main, which will bifurcate at point T and lead water to reservoirs at A and V respectively, the bed level of which will be at R L. 750 with a depth of 10 feet. This level will be sufficient to irrigate the whole of the New Capital with the exception of some small rocky portions. The area to the south of line * * has been considered in detail for the purposes of this estimate. This area is served from reservoir A, and two mains have been laid out *viz.*, A, A_1, A_2, A_3, A_4, A_5, A_6, A_7, and A, B_1, B_2, B_3, B_4, B_5. From these mains distributing pipes follow each road, and the service pipes lead from the distributing pipes. The area served by main A—A_7, is hachured red while that served by main A—B_5, is hachured blue.

There are two systems of delivery considered, *viz.*, (1) delivery in 12 hours or at the rate of 25 cusecs for each reservoir (2) delivery in 24 hours or at the rate of $12\frac{1}{2}$ cusecs from each reservoir the same rate as the pumping from the river.

The figures given on each area represent the number of gallons per minute required to water that area, assuming a delivery in 12 hours, and for a 24 hours delivery these figures should be divided by 2.

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* Not printed.

Each reservoir is calculated to hold a 12-hour supply, and will act as a balancing tank, as well as providing a stand by in case of a temporary break down of the pumping plant, and their cost is comparatively so small as to render the extra cost well worth the additional guarantee of safety, given by their inclusion in the scheme.

9. Power required.

The low level of the river at Indarpat is R. L. 657. The pumping level is therefore taken at R. L. 655; water has to be pumped to R. L. 760; there is thus a static head of 105 feet.

The friction head, in the mains is 20 feet, giving a total head of 125 feet.

The power required to pump 25 cusecs against a head of 125 feet is

$$\frac{25 \times 62\cdot5 \times 60 \times 125}{33,000} = 355 \text{ H. P.}$$

Allowing 25 percent for mechanical disadvantage and slip in the pumps, the H. P. required will be $355 \times \frac{100}{80} = 444$ H. P.

It is assumed that the pumps will be working for 300 days in the year. The number of Horse power-hours will therefore be $444 \times 300 \times 24 =$ 3,204,800 H. P. hours.

10. Size of pipes required.

The rising mains have already been stated to be 33″ each, giving a loss by friction of 20 feet.

The sizes, lengths and weights in cwts. as also the cost of the distributing and service pipes have been worked out in detail, *vide* appendix C, and are given below both for a 24 hours and a 12 hours delivery (*N. B.*—The service pipes serving private residences and all areas except public parks have been omitted as they are a charge against the owners of such areas).

Lengths of pipe line.

Mains.	Yards.	Size.	
		12 hours delivery.	24 hours delivery.
		Inches.	Inches.
AA_1 = ...	792	27	21
A_1A_2 = ...	968	27	21
A_2A_3 = ...	3080	24	18
A_3A_4 = ...	176	18	15
A_4A_5 = ...	176	18	12
A_5A_6 = ...	176	18	12
A_6A_7 = ...	528	15	10
$A B_1$ = ...	933	30	24
B_1B_2 = ...	1725	21	16
B_2B_3 = ...	1584	18	15
B_3B_4 = ...	880	13	12
B_4B_5 = ...	669	15	10

Distributing pipes.	Yards.	12 hours delivery.	24 hours delivery.
		Inches.	Inches.
C D	1327	12	9
B_2D	1327	12	9
E F	537	8	6
B_3Q	453	8	6
B_4R	453	8	6
B_5S	453	8	6
H G	453	8	6
F G	2363	8	6
H J	4067	8	6
J K	417	8	6
$K A_7$	1300	8	6
A_7B_5	2637	8	6
B_4A_5	2503	8	6
B_3A_5	2473	8	6
B_2A_4	2250	8	6
$N A_3$	2007	8	6
L M	643	8	6
M N	703	8	6
$N B_2$	1040	8	6
B_2O	1223	8	6
O P	674	8	6
$O B_1$	580	8	6
O N	600	8	6
A_1M	607	8	6

Weight of pipes.

		cwts.
30″	weight per yard	9·2
27″	" " "	8·1
24″	" " "	7·2
21″	" " "	5·75
18″	" " "	4·4
16″	" " "	3·6
15″	" " "	3·25
12″	" " "	2·38
10″	" " "	1·75
9″	" " "	1·6
8″	" " "	1·33
6″	" " "	0·92
3″	" " "	0·38

TOTAL WEIGHT OF PIPES.

12 hours delivery.

					cwts.
30″	...	... 933 × 9·2	...	...	8,584
27″	...	... 1760 × 8·1	...	...	14,256
24″	...	... 3080 × 7·2	...	...	22,276
21″	...	... 1725 × 5·75	...	...	9,919
18″	...	... 2992 × 4·4	...	...	13,165
15″	...	... 1197 × 3·25	...	...	3,890
12″	...	... 2654 × 2·38	...	...	6,317
8″	...	... 28436 × 1·33	...	...	37,915
3″	...	... 30000 × 0·38	...	...	11,400
					1,27,722
		Multiply by two for the whole area		...	1,27,722
					2,55,444

Cost at Rs. 8 per cwt. *plus* 10 per cent =Rs. 22,47,907.

---

24 hours delivery.

					cwts.
24″	...	... 933 × 7·2	...	...	6,718
21″	...	... 1760 × 5·75	...	...	10,120
18″	...	... 3080 × 4·4	...	...	13,552
16″	...	... 1725 × 3·6	...	...	6,210
15″	...	... 1760 × 3·25	...	...	5,720
12″	...	... 1232 × 2·38	...	...	2,932
10″	...	... 1197 × 1·75	...	...	2,095
9″	...	... 2654 × 1·6	...	...	4,246
6″	...	... 28436 × 0·92	...	...	26,161
3″	...	... 30000 × 0·38	...	...	11,400
					89,154
		Multiply by two for the whole area		...	89,154
					1,78,308

Cost at Rs. 8 per cent *plus* 10 per cent =Rs. 15,69,110.

11. Size of reservoirs.

Each reservoir has to hold 12 hours supply, pumped at the rate of $12\frac{1}{2}$ cusecs.

Allowing a depth of 10 feet of water with 2 feet free board, the cubical contents will be $12\frac{1}{2} \times 60 \times 60 \times 12 \times 12\text{-}10$ or 644,000 cubic feet.

12. Cost.

The initial cost consists of—

(*a*) Cost of pumps and buildings connected therewith.
(*b*) Cost of reservoirs.
(*c*) Cost of rising mains.
(*d*) Cost of distributing pipes.
(*e*) Cost of service pipes.
(*f*) Cost of valves, etc.

The recurring expenditure consists of—

(*a*) Interest on capital expenditure.

(*b*) Maintenance of pumps, buildings, pipe lines, etc.

(*c*) Depreciation and repairs of pumps.

(*d*) Depreciation and repairs of pipes.

(*e*) Cost of power.

(*a*) The cost of pumps and buildings may be taken at Rs. 650 per H. P. *plus* 50 per cent to allow of spare parts.

The cost is therefore $444 \times 650 \times \frac{3}{4}$=Rs. 4,32,900.

(*b*) The reservoirs are assumed to be open ones lined with 6″ of concrete throughout.

Excavation at Rs. 20 o/oo c.ft.				
$= 2 \times 644\,000 \times \frac{20}{1000}$	...		= Rs. 25,760	
Concrete at Rs. 25 per cent	644×10 ...	...	=	6,440 c.ft.
	400×10 ...	...	=	4,000 „
	322×200 ...	...	=	64,200 „
				74,840 „
	Add for second reservoir	...		74,840 „
				$1{,}59{,}680 \times \frac{25}{100}$
				= Rs. 39,920
	Total	...		Rs. 65,680

(*c*) Each rising main is 4·89 miles long. The weight of a 33″ pipe per yard is 1,150 lbs. or 10·3 cwts.

The cost is therefore $2 \times 4{\cdot}89 \times 1760 \times 10{\cdot}3 \times$ Rs. 8·8* = Rs. 15,59,480.

* Allowing Rs. 8 per cwt. *plus* 10 per cent for breakages, etc.

(*d*) and (*e*) Cost of distributing and service pipes for a 12 hours delivery	...	Rs. 22,47,907
for a 24 hours delivery	...	Rs. 15,69,110
(*f*) Cost of valves, etc., may be taken as		Rs. 1,50,000

The total initial expenditure is therefore—

(*a*) Cost of pumps, etc...	...	...	...	Rs. 4,32,900
(*b*) Cost of reservoirs ...	...	...	...	„ 65,680
(*c*) Cost of rising main...	...	...	...	„ 15,59,480
(*d*) and (*e*) Cost of distributing and service pipes (for a 12 hours delivery)	...	...	...	„ 22,47,907
(*f*) Cost of valves, etc.	...	...	...	„ 1,50,000
		Total	...	„ 34,55,967
		Add 10 per cent contingencies	...	„ 4,45,597
		Total	...	„ 49,01,564

(*Note.*—If a 24 hours delivery is given the capital cost will be Rs. 41,54,887.)

The recurring expenditure consists of—

(*a*) Interest on capital expenditure, at 4 per cent.

(*b*) Maintenance at $3\frac{1}{2}$ per cent on cost of reservoirs, pumps and pipes

(*c*) Depreciation and repairs of pumps at 6 per cent on cost of pumps.

(*d*) Depreciation and repairs of pipes at 3 per cent on cost of pipes.

(*a*) 4 per cent on Rs. 49,01,564	...	...	Rs. 1,96,062
4 per cent on " 41,54,887	...	...	" 1,66,195
(*b*) $3\frac{1}{2}$ per cent on " 49 09,564	...	...	" 1,71,561
$3\frac{1}{2}$ per cent on " 41,54,887	...	...	" 1,45,421
(*c*) 6 per cent on " 4,76,190	...	...	" 28,571
(*d*) 3 per cent on " 43 53,126	...	...	" 1,30,594
3 per cent on " 3?,56,449	...	...	" 1,08,192

For a 12 hours delivery the cost is

(*a*)	...	" 1,96,062
(*b*)	...	" 1,71,561
(*c*)	...	" 28,571
(*d*)	...	" 1,30,594
Total cost of interest, maintenance and depreciation on 12 hours delivery	...	" 5,26,788

For a 24 hours delivery the cost is

(*a*)	...	Rs. 1,66,195
(*b*)	...	" 1,45,421
(*c*)	...	" 28,571
(*a*)	...	" 1,88,192
Total cost of interest, maintenance and depreciation for a 24 hours delivery	...	" 4,48,379

(*e*) Allowing a rate of 0-1-0 per H. P hour (which is probably excessive) the cost of power will be 3,204,800 $\times \frac{1}{16}$ = Rs. 2,00,300.

The recurring expenditure for a 12 hours delivery is therefore:—

Total of (*a*), (*b*), (*c*) and (*d*)	...	Rs. 5,26,788
Cost of power	...	" 2,00,300
Total	...	" 7,27,088

For a 24 hours delivery.

Total of (*a*), (*b*), (*c*) and (*d*)	...	Rs. 4,48,379
Cost of power	...	" 2,00 300
Total	...	" 6 48,679

To recapitulate the capital cost for a 12 hours delivery amounts to ...	Rs. 49,01,5?4
and the recurring expenditure to ...	" 7,27,088
for a 24 hours delivery there is a saving in the capital cost of	" 7,46,677
and in recurring expenditure to ...	" 78,409

13. Cost per acre actually irrigated per acre protected and the number of gallons per rupee.

(*a*) The number of acres actually irrigated is $\frac{3}{8} \times 12 \times 640 = 2,880$ acres.

With a 12 hours delivery the cost per annum per acre actually irrigated will be $\frac{7,27,088}{2,880}$ = Rs. 252, or Rs. 21 per acre per mensem.

With a 24 hours delivery the cost per annum per acre actually irrigated will be $\frac{6,48,679}{2,880}$ = Rs. 225

or Rs. 18-12 per acre per mensem.

(*b*) The number of acres protected is 12 × 640 = 7,680 acres.

With a 12 hours delivery the cost per annum per acre protected will be $\frac{7,27,088}{7,680}$ = Rs. 95

or Rs. 8 per acre per mensem.

With a 24 hours delivery the cost per annum per acre protected will be $\frac{6,48,679}{7,680}$ = Rs. 84

or Rs. 7 per acre per mensem.

Note.—It will be seen from these figures that the cost of irrigating a 4 acre compound will be Rs. 32 or Rs. 28 per mensem, according to whether a 12 or 24 hours delivery is given.

(*c*) the number of gallons pumped per annum is 25 × 3,600 × 24 × 300 × $\frac{25}{4}$ = 4,050,000,000.

For a 12 hours delivery, the number of gallons per rupee will be $\frac{4,050,000,000}{7,727,088}$ = 5,570 gallons per rupee.

For a 24 hours delivery, the number of gallons per rupee will be $\frac{4,050,000,000}{6,48,679}$ =6,244 gallons per rupee.

14. Final remarks.

(*a*) It should be noted that this estimate allows for an unfiltered water supply, and great increase in expense would be incurred if a separate filter supply for irrigation alone were introduced.

(*b*) The lowest level of the bed of the distributing reservoir must be at R. L. 750 to allow of irrigation over the area. To ensure economical reservoirs they have therefore been located on the ridge. An economical reservoir on some of the isolated hills, such as Rai Sina, would have a bed level at about R. L. 710, and this would give insufficient head to water more than a very small fraction of the area. A reservoir raised some 50 feet, would therefore be necessary if any such point were taken and this would be very costly and difficult to fit in with the lay out aesthetically.

15. Memorandum of points requiring decision before the preparation of a project estimate.

It may assist if a list of points is given on which orders are required before a project estimate can profitably be undertaken.

The list is as follows :—

(1) Localities for which irrigation should be provided.

(2) Intensity of irrigation.

(3) Whether the supply should be filtered or unfiltered.

(4) If unfiltered—

(*a*) Whether the sewage effluent should be pumped up or not.

(*b*) To what extent subsoil, canal, and river supply should be utilised.

(5) Situation of pumping station, and reservoirs.

(6) Source of power and class of pumps and engines.

Note.—If filtered, the points of reference can best be dealt with under drinking water supply.

16. Schedule of rates employed in this estimate.

For convenience in reference a schedule of rates used in this estimate is given in a statement (Appendix D).

17. Forecast of yearly expenditure.

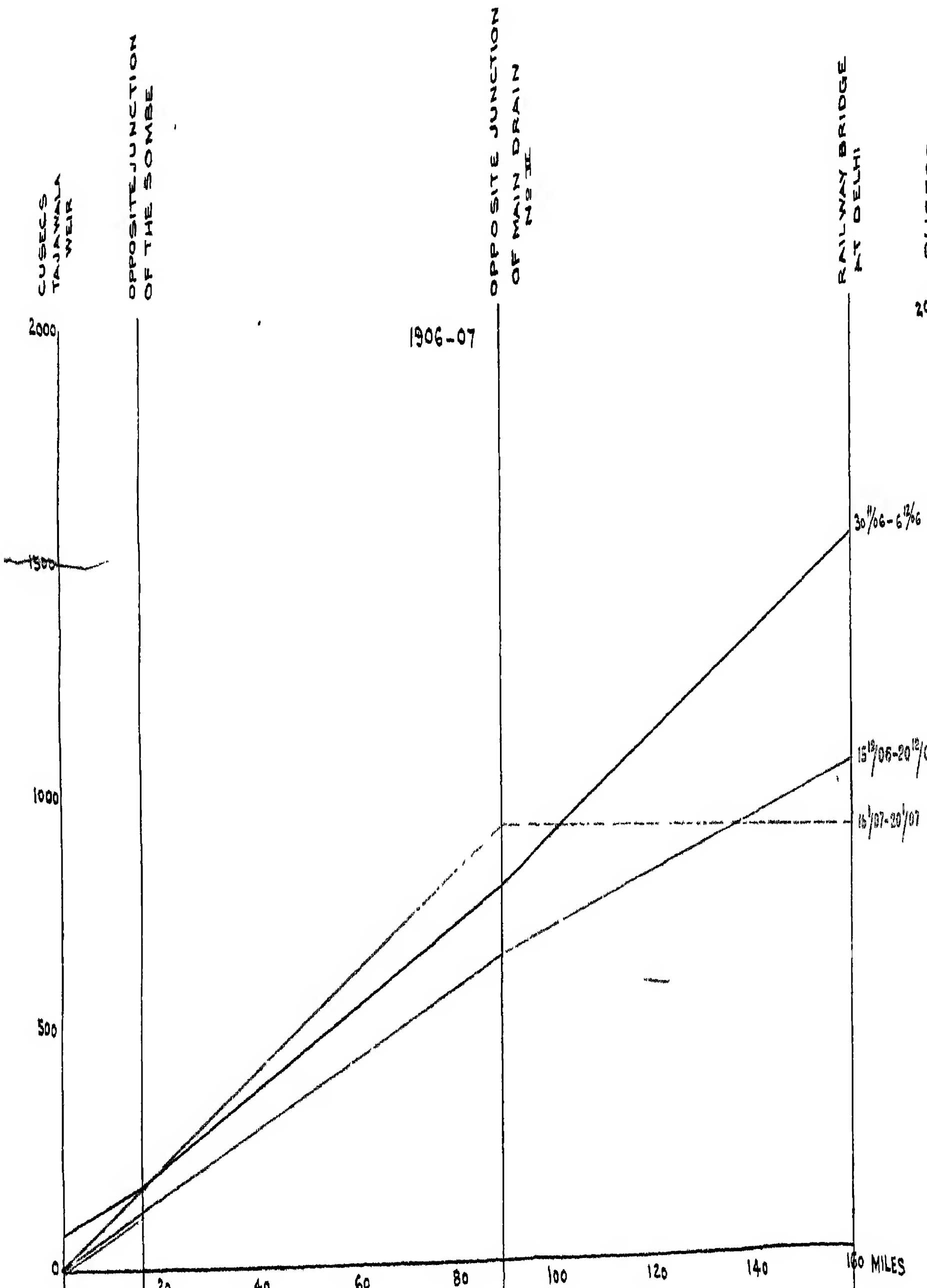
A forecast of yearly expenditure is given in a statement (Appendix E) to assist in organising establishment and financial arrangements.

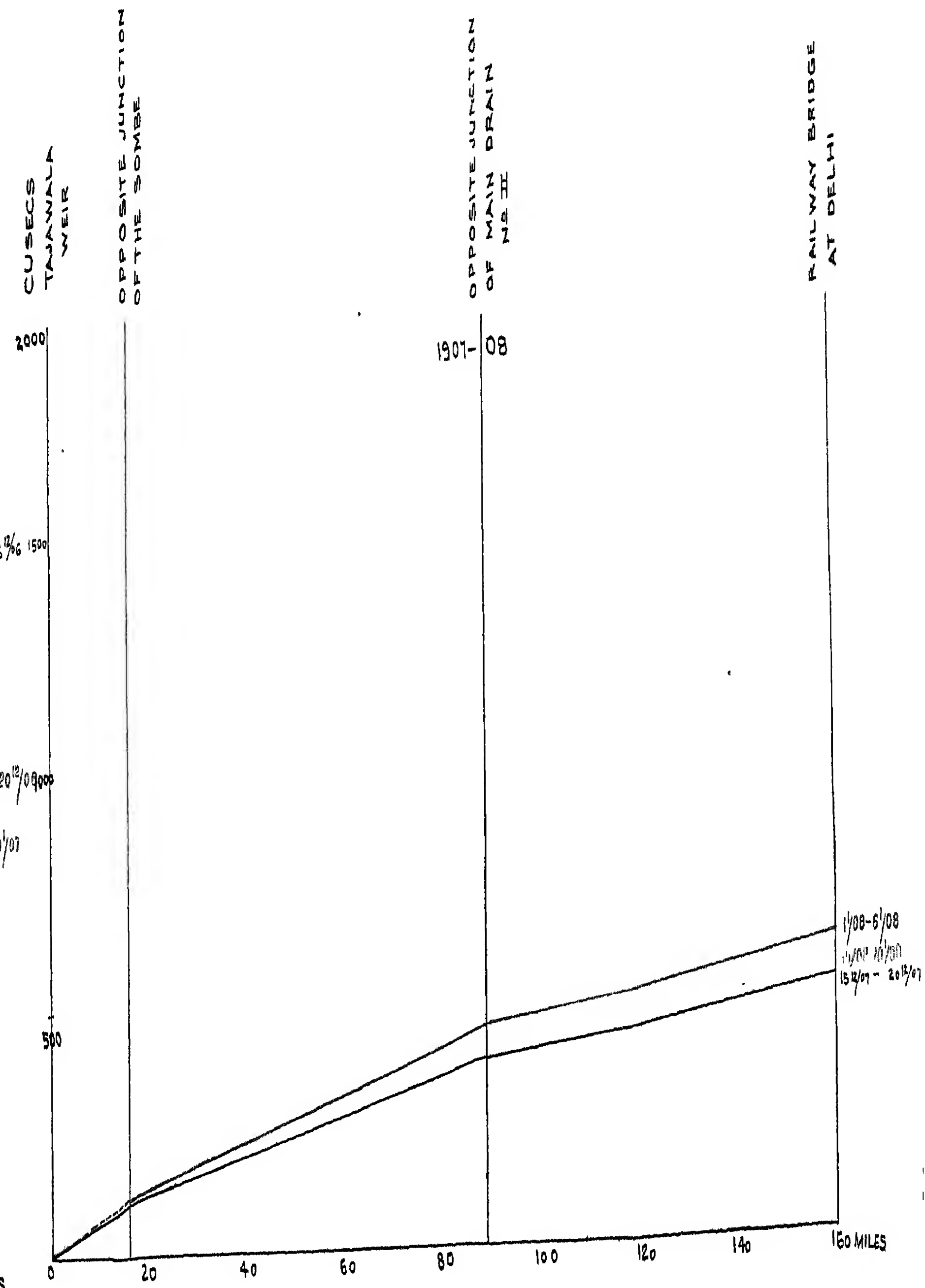
APPENDIX (A)

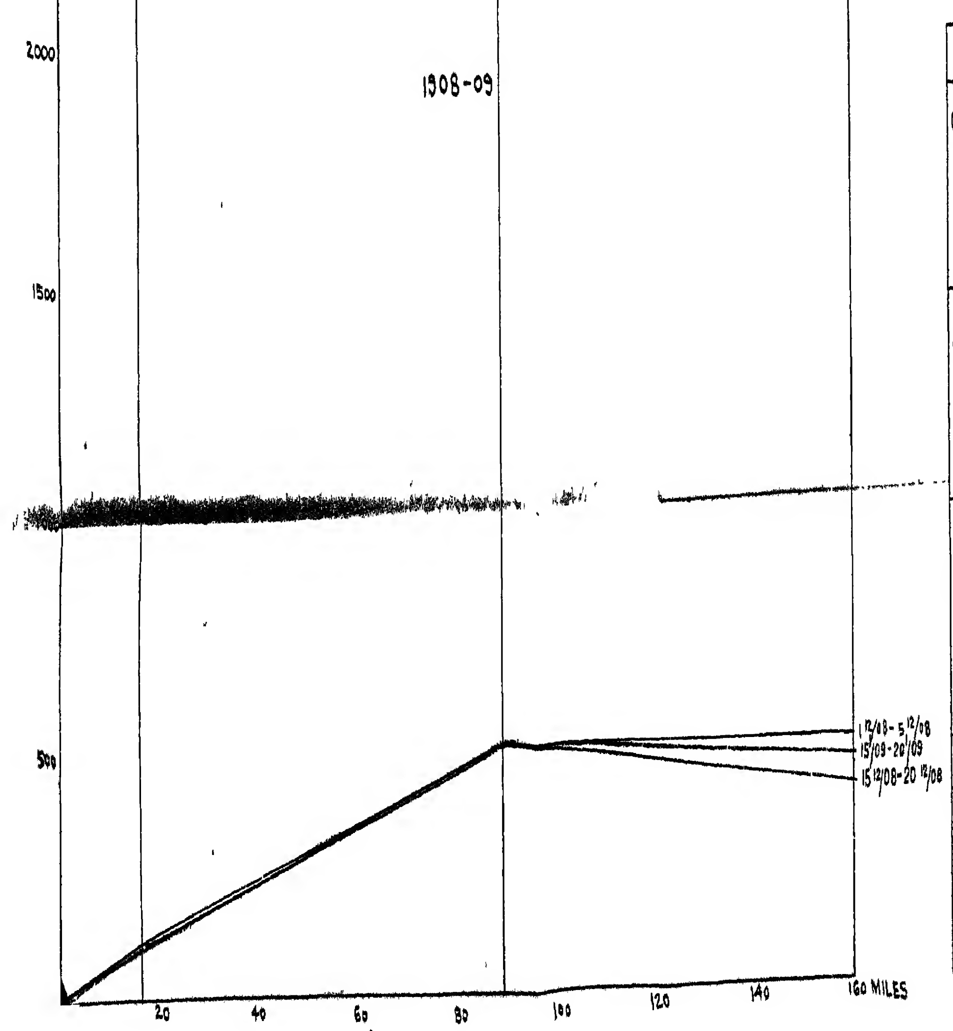
NEW CAPITAL DELHI

IRRIGATION

DIAGRAM TO SHOW THE EXTENT TO WHICH WATER SPRINGS UP IN THE BED OF THE RIVER JUMNA FROM THE SIWALIKS TO DELHI







RATE OF INCREASE OF INFLOW INTO RIVER JUMNA BED IN CUSECS PER MILE

	FROM	TO	1906-07					1907-08			1908-09				
			DEC.	DEC.	JAN.	JAN.	FEB.	DEC.	JAN	JAN	DEC	DEC.	JAN.	JAN.	FEB.
(1)	TAJAWALA WEIR	OPPOSITE JUNCTION OF THE SOMBE	+6·88	+8·19	+7·75	+10·38	+7·25	+6·81	+6·56	+8·19	+6·50	+7·19	+7·13	+6·31	+6·25
(2)	OPPOSITE JUNCTION OF THE SOMBE	OPPOSITE JUNCTION OF MAIN DRAIN No II	+8·22	+6·84	+7·03	+9·93	+6·47	+3·57	+4·72	+3·85	+5·86	+5·46	+5·82	+5·42	+4·47
(3)	OPPOSITE JUNCTION OF MAIN DRAIN No II	RAILWAY BRIDGE AT DELHI	+10·26	+5·31	-2·29	-0·43	-1·27	+2·13	+2·54	+1·93	-0·33	-1·50	+0·06	-0·79	-1·97
(4)	TAJAWALA WEIR	RAILWAY BRIDGE AT DELHI	+8·98	+6·31	+3·03	+5·45	+3·15	+3·38	+3·95	+3·44	+3·22	+2·53	+3·43	+2·89	+1·85

NOTE

THE DISTANCES ARE MEASURED ALONG THE WINDING COURSE OF THE RIVER

[redacted] ithe Dept., Thomason College, Roorkee.

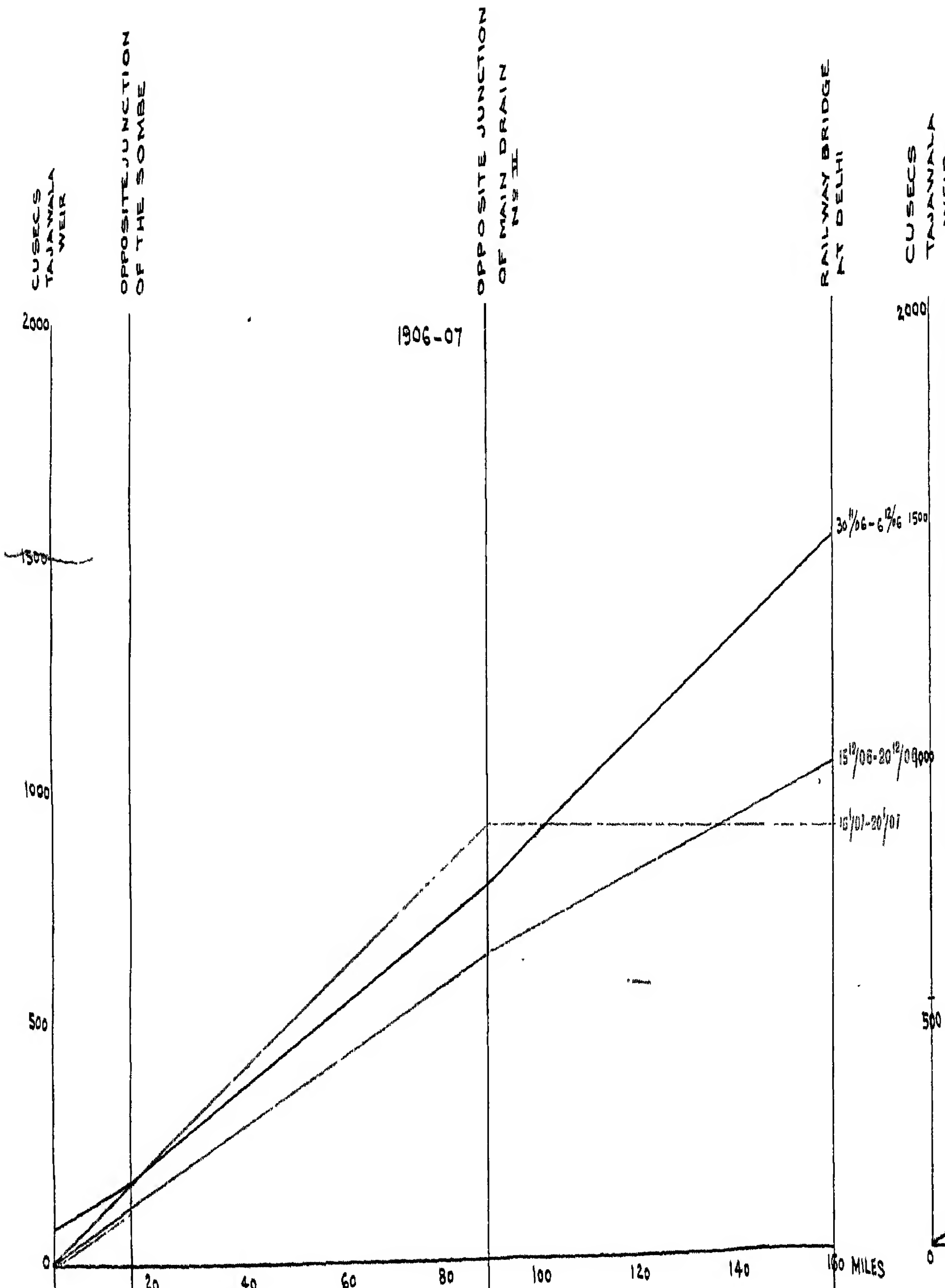
Zinco October, 1912—No. 9463-19.50.

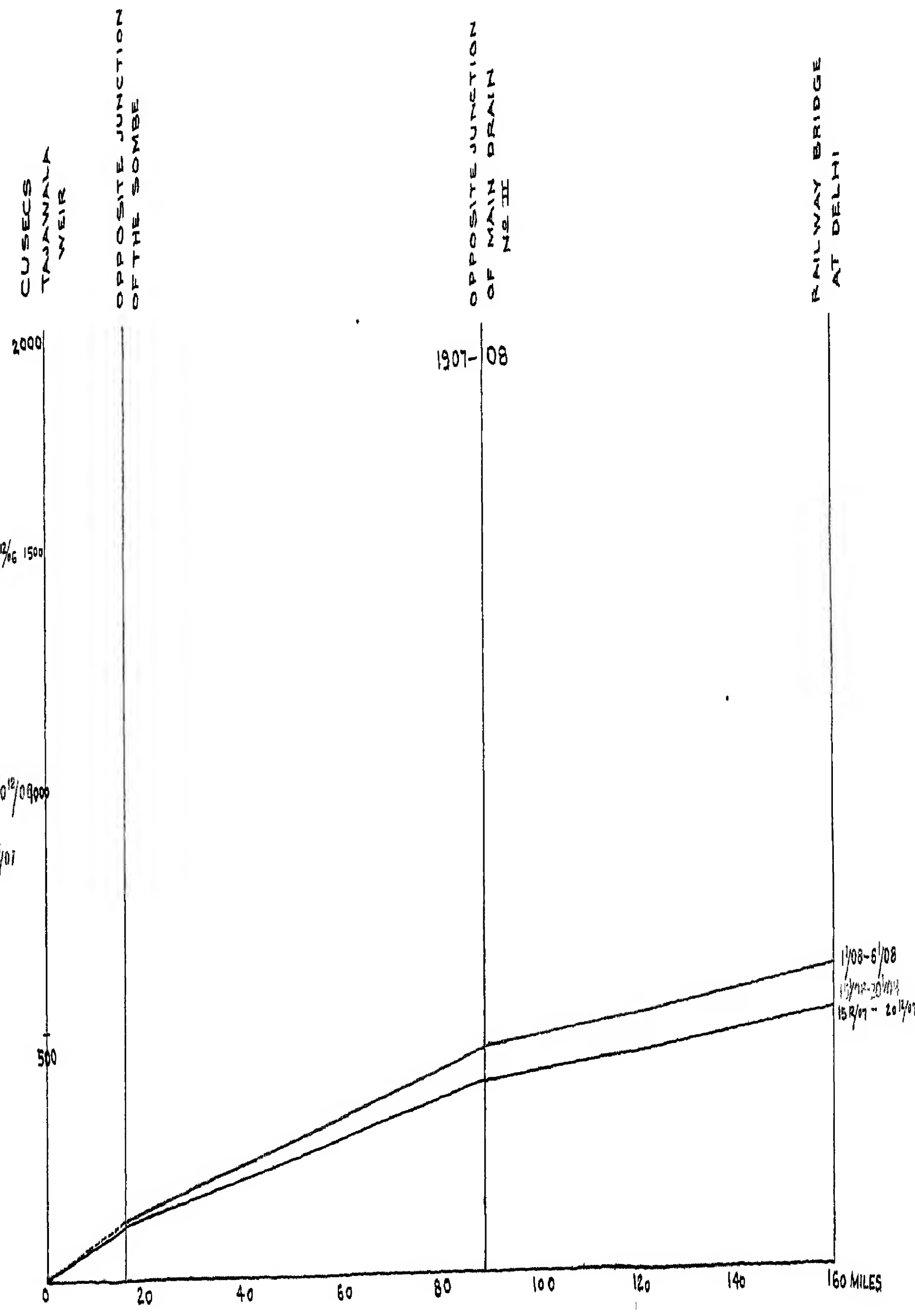
NEW CAPITAL DELHI

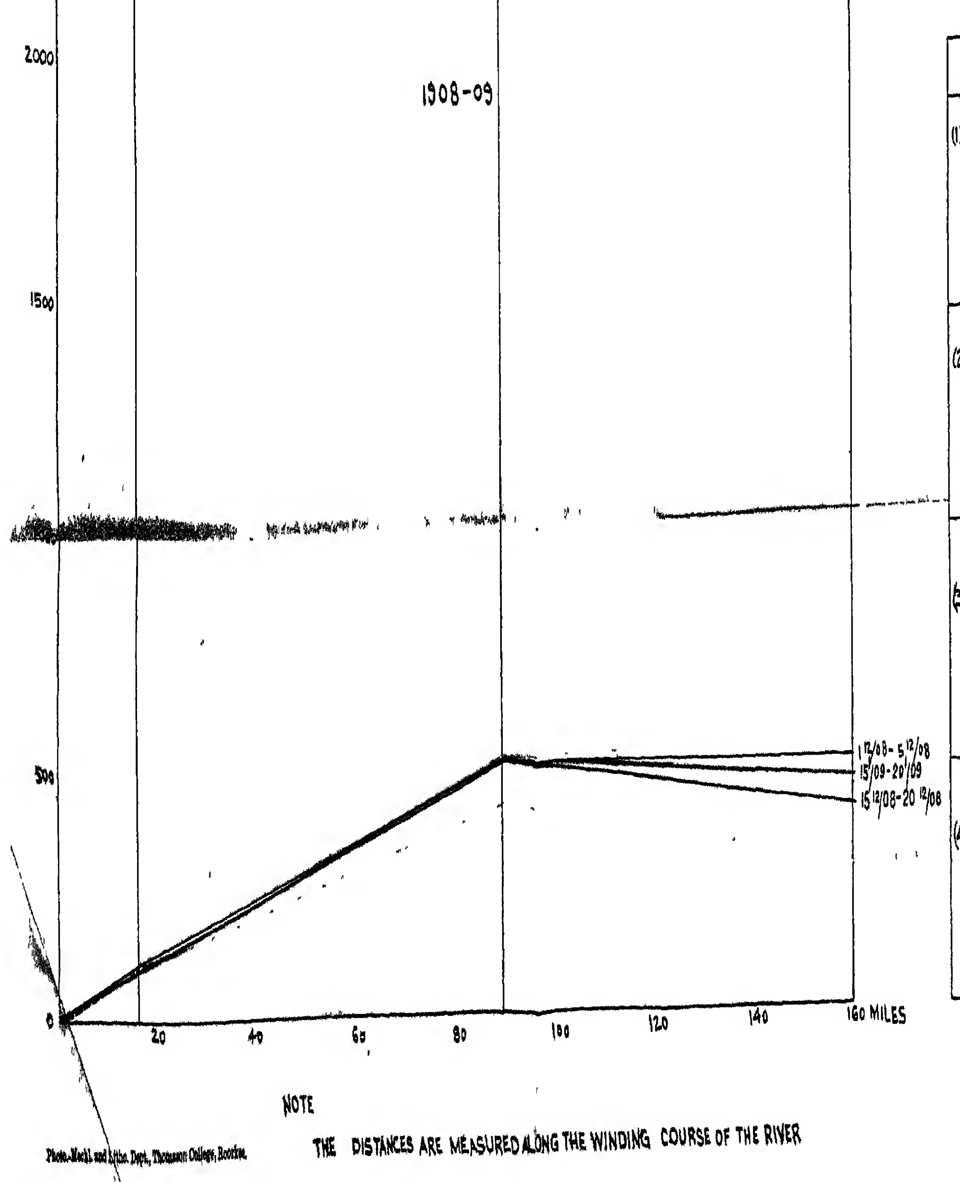
APPENDIX (A)

IRRIGATION

DIAGRAM TO SHOW THE EXTENT TO WHICH WATER SPRINGS UP IN THE BED OF THE RIVER JUMNA FROM THE SIWALIKS TO DELHI







NOTE

THE DISTANCES ARE MEASURED ALONG THE WINDING COURSE OF THE RIVER

RATE OF INCREASE OF INFLOW INTO RIVER JUMNA BED IN CUSECS PER MILE

	FROM	TO	1906-07					1907-08			1908-09				
			DEC:	DEC·	JAN·	JAN·	FEB:	DEC·	JAN	JAN	DEC	DEC:	JAN:	JAN·	FEB:
(1)	TAJAWALA WEIR	OPPOSITE JUNCTION OF THE SOMBE	+6·88	+8·19	+7 75	+10·38	+7 25	+6 81	+6 56	+8·19	+6 50	+7·19	+7·13	+6 31	+6·25
(2)	OPPOSITE JUNCTION OF THE SOMBE	OPPOSITE JUNCTION OF MAIN DRAIN No II.	+8 22	+6·84	+7·03	+9·93	+6 47	+3·57	+4·72	+3·85	+5·86	+5·46	+5·82	+5·42	+4·47
(3)	OPPOSITE JUNCTION OF MAIN DRAIN No II	RAILWAY BRIDGE AT DELHI	+10 26	+5 31	-2 29	-0 43	-1 27	+2 13	+2 54	+1 93	-0 33	-1 50	+0 06	-0 79	-1 97
(4)	TAJAWALA WEIR	RAILWAY BRIDGE AT DELHI	+8 98	+6 31	+3·03	+5 45	+3 15	+3 38	+3 95	+3 44	+3·22	+2·53	+3·43	+2·89	+1·85

Photo.-Mech'l. and Litho. Dept., Thomason College, Roorkee.

Zinco. October, 1912.—No. 9483-19.50.

APPENDIX B.

Actual discharges of the river Jumna at Delhi during 1912.

Date.		Gauge.	Discharge.	Observer.
			cusecs	
11th February 1912	...	663·45	1610	Mr. Smith.
28th March 2912	...	663·15	302	Do.
4th April 1912	...	Not given.	478	Mr. Sale.
11th April 1912	...	663·15	380	Do.
19th April 1912	...	663·20	442	Do.
27th April 1912	...	663·40	296	Mr Smith.
30th April 1912	...	663·00	305	Mr. Sale.
7th May 1912	...	662·90	458	Do.
29th May 1912	...	662·80	150	Mr. Smith.
6th June 1912	...	662·55	94	Do.
22nd June 1912	...	662 50	95	Do.
28th June 1913	...	662·40	64	Do.
2nd July 1912	...	662·40	71	Mr. Sale.
4th July 1912	...	662·30	64	Mr. Smith.

APPENDIX C.

The attached diagram (1) gives the sizes of pipes required in the mains assuming (*a*) that the whole supply is delivered in 2 hours—

(*b*) that the whole supply is delivered in 24 hours,

(*c*) that the bed level of the reservoirs is at R. L. 750, the minimum level to allow of irrigation of the most important portions of the area.

The final calculation gives the size of distributing pipe required for the area at the end of the main, which requires a supply of 525 gallons per minute, the sizes calculated for this are (1) 10″ for a 12 hours supply, (2) 8″ for a 24 hours supply, but as, there are two pipes bifurcating from the end of the main 8″ and 6″ pipes have been allowed for.

The remaining distributing pipes have to discharge quantities of water such as 350, 265, 200, etc., gallons per minute under varying heads, which approximate to the residual head of 10 feet, allowed at the end of main A A_1, A_7, and therefore an average size of 8″ for a 12 hours and 6″ for a 24 hours delivery has been taken for all distributing pipes.

The service pipes throughout have been taken as 3″ pipes, as any smaller size is considered not to be practical for irrigation water for considerations of silt carried in unfiltered water.

The attached diagram (2) gives the sizes of pipes required in the mains assuming (*a*) that the whole supply is delivered in 12 hours (*b*) that the whole supply is delivered in 24 hours (*e*) that the bed level of the reservoir is at R. L. 775.

This has been worked out as a guide to discover whether placing the bed of the reservoirs at R. L. 750 is more economical than placing the bed at a higher level, thus getting a greater head.

As the value of the mains is greater than that of the distributing and service pipes combined, the greatest economy can be effected by making the hydraulic gradient of the mains a maximum, and this has been done in the diagrams, the residual heads at A_7 of 10 feet and at B_5 of 14 feet being considered the ninimum that can be allowed to ensure efficient distribution over the areas, watered by distributing pipes, leading from the ends of the mains.

The sizes of the distributing pipes are taken at the previous figures as the head, where they take off from the mains, is but slightly altered.

It will be seen from the figures in the diagrams (allowing for standard sizes of pipes) that the difference in sizes according to whether the beds of the reservoirs are at R. L. 750 or at R. L. 775 is as follows:—

Pipes.	SIZE OF PIPES.			
	12 HOURS DELIVERY.		24 HOURS DELIVERY.	
	Bed of reservoir at R.L. 750.	Bed of reservoir at R.L. 775.	Bed of reservoir at R.L. 750.	Bed of reservoir at R.L. 775.
$A A_2$	27"	21"	21"	18"
$A_2 L$	27"	21"	21"	16"
$L A_3$	24"	21"	18"	16"
$A_3 A_4$	16"	16"	13"	12"
$A_4 A_5$	15"	14"	12"	11"
$A_5 A_6$	14"	13"	11"	10"
$A_6 A_7$	13"	12"	10"	9"
$A B_1$	30"	24"	24"	18"
$B B_2$	21"	21"	18"	16"
$B_2 B_3$	18"	16"	13"	12"
$B_3 B_4$	15"	14"	12	11"
$B_4 B_5$	13"	12"	10"	10"

The weight of the pipes is:—

Bed of reservoir at R. L. 750.

		12 hours delivery—	Cwts.		*24 hours delivery—*	Cwts.
$A\,A_2$	... ...	1760 × 8·1 =	14256	...	1760 × 5·75 =	10120
$A_2\,L$	... ...	690 × 8·1 =	5589	...	690 × 5·75 =	3968
$L\,A_3$	... ...	2390 × 7·2 =	17208	...	2390 × 4·4 =	10516
$A_3\,A_4$	... ...	176 × 3·6 =	634	...	176 × 2·66 =	469
$A_4\,A_5$	... ...	176 × 3·25 =	572	...	176 × 2·38 =	419
$A_5\,A$	... ...	176 × 2·9 =	510	...	176 × 2·0 =	352
$A_6\,A_7$	... ...	528 × 2·66 =	1408	...	528 × 1·75 =	924
$A\,B_1$	... ...	933 × 9·2 =	8384	...	953 × 7·2 =	6718
$B_1\,B_2$	... ...	1725 × 5·75 =	9919	...	1725 × 4·4 =	7590
$B_2\,B_3$	... ...	1584 × 4·4 =	6970	...	1584 × 2·66 =	4224
$B_3\,B_4$	... ...	880 × 3·25 =	2860	...	880 × 2·38 =	2094
$B_4\,B_5$	... ...	669 × 2·66 =	1784	...	669 × 1·75 =	1171
			70294	...		48565
	Add for second half	...	70294	...		48565
	Total	...	140,588 Cwt.			97,130 Cwt.

Bed of reservoir at R. L. 775.

		12 hours delivery	Cwts.		*24 hours delivery*	Cwts.
$A\,A_2$	... ...	1760 × 5·75 =	10120	...	1760 × 4·4 =	7744
$A_2\,L$	... ...	690 × 5·75 =	3968	...	690 × 3·6 =	2484
$L\,A_3$	... ...	2390 × 5·75 =	13742	...	2390 × 3·6 –	8604
$A_3\,A_4$	... ...	176 × 3·6 =	634	...	176 × 2·38 =	419
$A_4\,A_5$	... ...	176 × 2·9 =	410	...	176 × 2·9 =	352
$A_5\,A_6$	... ...	176 × 2·66 =	469	...	176 × 1·75 =	308
$A_6\,A_7$	... ...	528 × 2·38 =	1257	...	528 × 1·6 =	845
$A\,B_1$	... ...	933 × 7·2 =	6718	...	933 × 4·4 =	4105
$B_1\,B_2$	... ...	1725 × 5·75 =	9919	...	1725 × 3·6 =	6210
$B_2\,B_3$	... ...	1584 × 3·6 =	4122	...	1584 × 2·38 =	3770
$B_3\,B_4$	... ...	880 × 2·9 =	2552	...	880 × 2·0 =	1760
$B_4\,B_5$	... ...	669 × 2·38 =	1592	...	669 × 1·75 =	1171
			55,603			37,772
	Add for second half	...	55,603			37,772
	Total	...	1,11,206 Cwt.			75,544 Cwt.

Taking the value at Rs. 8 per cwt. + 10 per cent for breakages, the cost of the mains for a 12 hours delivery is

1,40,588 × Rs. 8·8 if the bed of the reservoir is at R. L. 750

or Rs. 12,37,174.

and 1,11,206 × Rs. 8·8 if the bed of the reservoir is at R. L. 775

or Rs. 9,78,613.

and for a 24 hours delivery the cost is 97,130 × Rs. 8·8 if the bed of the reservoir is at R. L. 750

or Rs. 8,54,744 per cent

and 75,544 × Rs. 8·8 if the bed of the reservoir is at R. L. 775.

or Rs. 6,64,787.

The saving in cost of the mains, by placing the bed of the reservoir at R. L. 775 instead of at R. L. at 750 is—

(*a*) Rs. 2,58,561 for a 12 hours delivery, and

(*b*) Rs. 1,89,955 for a 24 hours delivery.

On the other hand, the length of each of the rising mains will be increased by half a mile, and the pumping head will be increased by 25 feet, the friction head remaining practically the same.

The weight of the extra length of rising mains is

2 × 880 yards × 10·3 cwts. = 18,128 cwts.

and the cost at Rs. 8 per cwt. + 10 per cent is Rs. 1,58,426.

The increase in the H. P. hours will be $\frac{125 + 25}{125} = \frac{6}{5}$ths of the amount previously calculated.

Or $\frac{6}{5}$ × 3,204,800, or 3,845,760 H. P. hours.

and this at 0-1-0 per H. P. hour is Rs. 2,40,360, or an increase in cost of Rs. 40,060.

The increase in H. P. is $\frac{1}{5}$th, *i.e.*, $\frac{1}{5}$ × 444 = 89

and this at 650 per H. P. + 50 per cent gives the increased cost of pumps and building as 89 × Rs. 650 × $\frac{3}{2}$ = Rs. 86,705.

Collecting these figures we find that the following is the comparison in capital cost.

Item.		12 HOURS DELIVERY.		24 HOURS DELIVERY.	
		Increase.	Decrease.	Increase.	Decrease.
		Rs.	Rs.	Rs.	Rs.
Pumps and buildings ...	...	86,705	...	86,705	...
Rising main	...	1,58,426	...	1,58,426	...
Distributing pipes ...	...	...	2,58,561	...	1,89,955
Totals	...	2,45,131	2,58,561	2,45,131	1,89,955
Total increase or decrease	...	...	13,430	55,176	...

i.e., there is a decrease in capital cost of Rs. 13,430 for a 12 hours delivery and in increase in capital cost of Rs. 55,176 for a 24 hours delivery.

Taking recurring expenditure.

(*a*) for a 12 hours delivery—

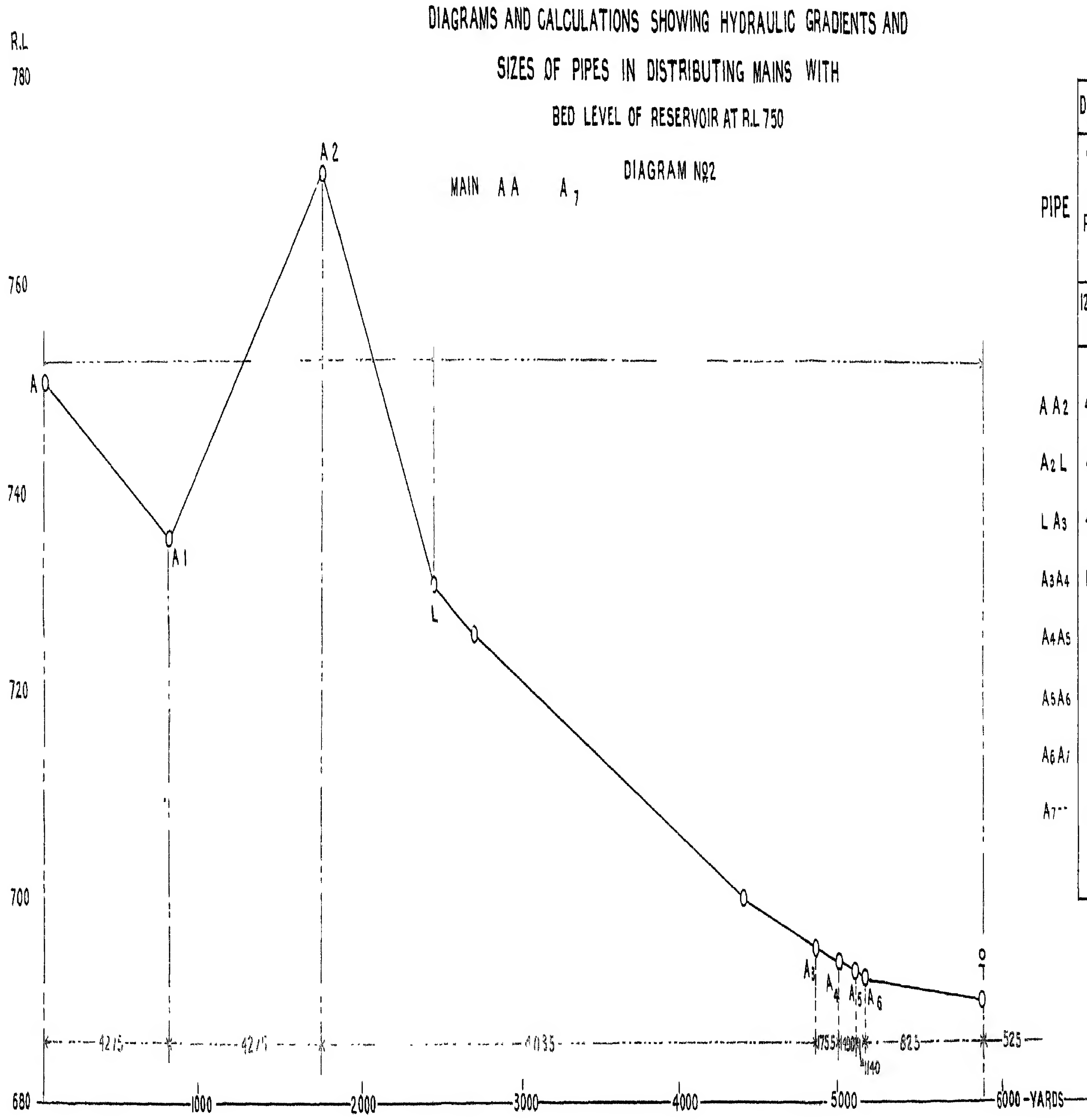
(1) there is a decrease of 4 per cent of Rs. 13430 interest on capital expenditure, or Rs. 537,

(2) there is a decrease of 3½ per cent of Rs. 13,,430 maintenance, or Rs. 470,

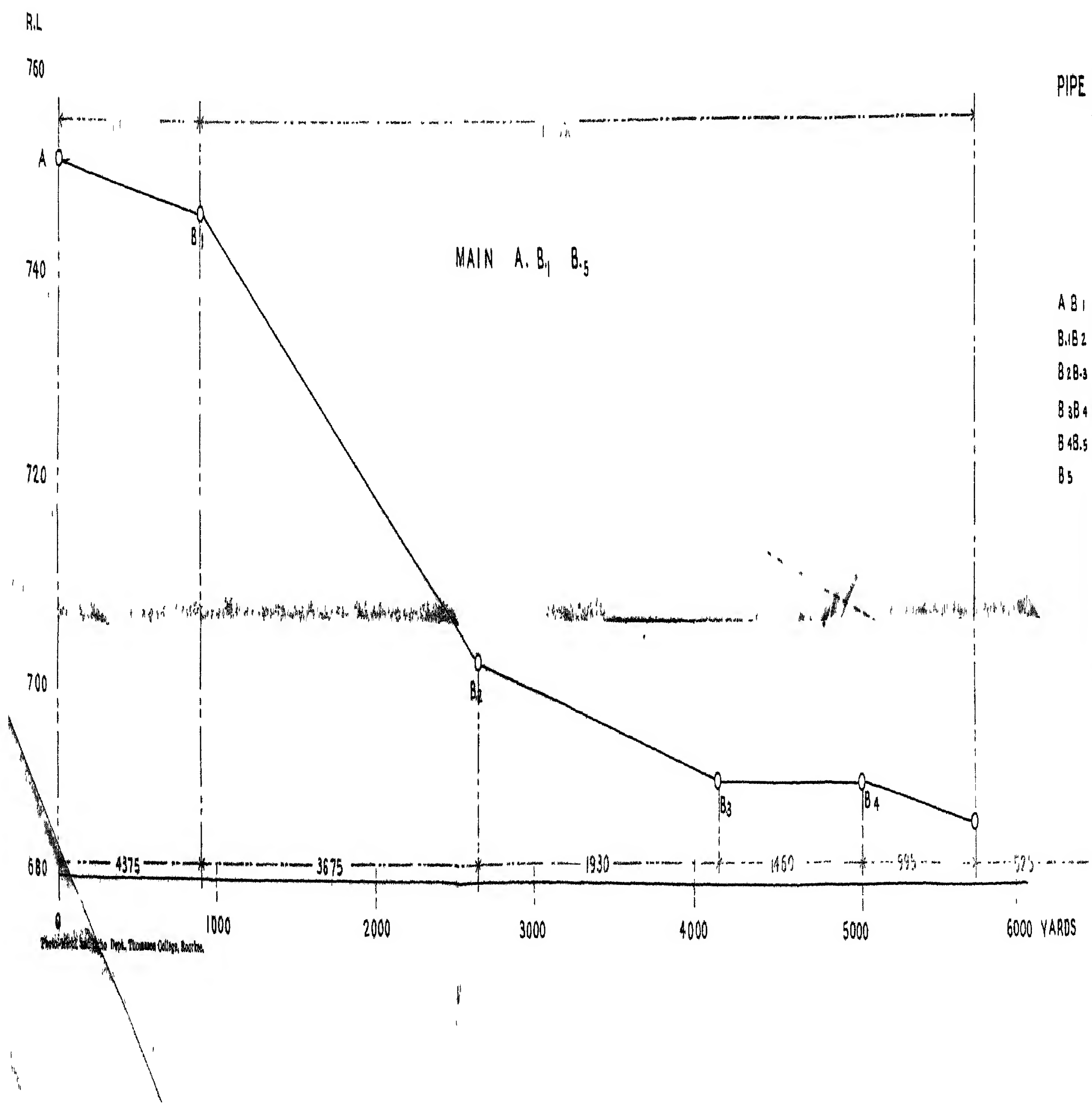
(3) there is an increase of 6 per cent of Rs. 86,705 depreciation and repairs of pumps, or Rs. 5.202,

DIAGRAMS AND CALCULATIONS SHOWING HYDRAULIC GRADIENTS AND SIZES OF PIPES IN DISTRIBUTING MAINS WITH BED LEVEL OF RESERVOIR AT R.L 750

DIAGRAM No2



PIPE	DISCHARGE TO BE CARRIED				HYDRAULIC GRADIENT	SIZE OF PIPE	
	GALLONS PER MINUTE		C FT PER MIN				
	12 HRS DEL	24 HRS DEL	12 HRS DEL	24 HRS DEL		12 HRS. DEL	24 HRS DEL
$A\,A_2$	4275	2138	684	342	1 IN 750	27"	21"
$A_2\,L$	4035	2018	646	323	1 IN 750	26"	20"
$L\,A_3$	4035	2018	646	323	1 IN 300	22"	17"
A_3A_4	1755	878	281	140	1 IN 300	16"	13"
A_4A_5	1490	745	238	119	1 IN 300	15"	12"
A_5A_6	1140	570	182	91	1 IN 300	14"	11"
A_6A_7	875	438	140	70	1 IN 300	13"	10"
A_7--	525	263	84	42	1 IN 300	10"	8"



PIPE	DISCHARGE TO BE CARRIED				HYDRAULIC GRADIENT	SIZE OF PIPE	
	GALLONS PER MINUTE		C FT PER MIN.				
	12 HPS DEL	24 HRS DEL	12 HRS DEL	24 HRS DEL		12 HRS DEL	24 HRS DEL
$A\,B_1$	4375	2188	700	350	1 IN 1400	30"	23"
B_1B_2	3625	1813	596	298	1 IN 300	21"	17"
B_2B_3	1930	965	309	155	1 IN 300	17"	13"
B_3B_4	1460	730	234	117	1 IN 300	15"	1"
B_4B_5	995	498	159	80	1 IN 300	13"	10"
B_5	525	263	84	42	1 IN 300	10"	8"

G. E. SOPWITH LT R. E.
OFFICER ON SPECIAL DUTY
HOME DEPARTMENT DELHI.

Photo-Litho. Dept. Thomason College, Roorkee.
Ibid October, 1913 —No. [illegible]

(4) there is a decrease of 3 per cent of Rs. 1,00,135 depreciation and repairs of pipes, or Rs. 3,005,

(5) there is an increase in cost of pumping as already shewn of Rs. 40,060.

(*b*) For a 24 hours delivery—

(1) there is an increase of 4 per cent of Rs. 55,875 interest on capital expenditure, or Rs. 2,207,

(2) there is an increase of $3\frac{1}{2}$ per cent of Rs. 55,176 maintenance, or Rs. 1,930,

(3) there is an increase of 6 per cent of Rs. 86,705 depreciation and repairs of pumps, or Rs. 5,202,

(4) there is a decrease of 3 per cent of Rs. 31,529 depreciation and repairs of pipes, or Rs. 946,

(5) there is an increase in cost of pumping of Rs. 40,060.

Tabulating the results of recurring expenditure we get.

Item.	12 HOURS DELIVERY.		24 HOURS DELIVERY.	
	Increase.	Decrease.	Increase.	Decrease.
	Rs.	Rs.	Rs.	Rs.
(1) Interest on capital cost	...	537	2,207	...
(2) Maintenance	...	470	1,930	...
(3) Depreciation and repairs of pumps ...	5,202	...	5,202	...
(4) Depreciation and repairs of pipes ...	...	3,005	...	946
(5) Cost of power	40,060	...	40,060	...
Totals ...	45,262	4,012	49,399	946
Total increase or decrease ...	41,250	...	48,453	...

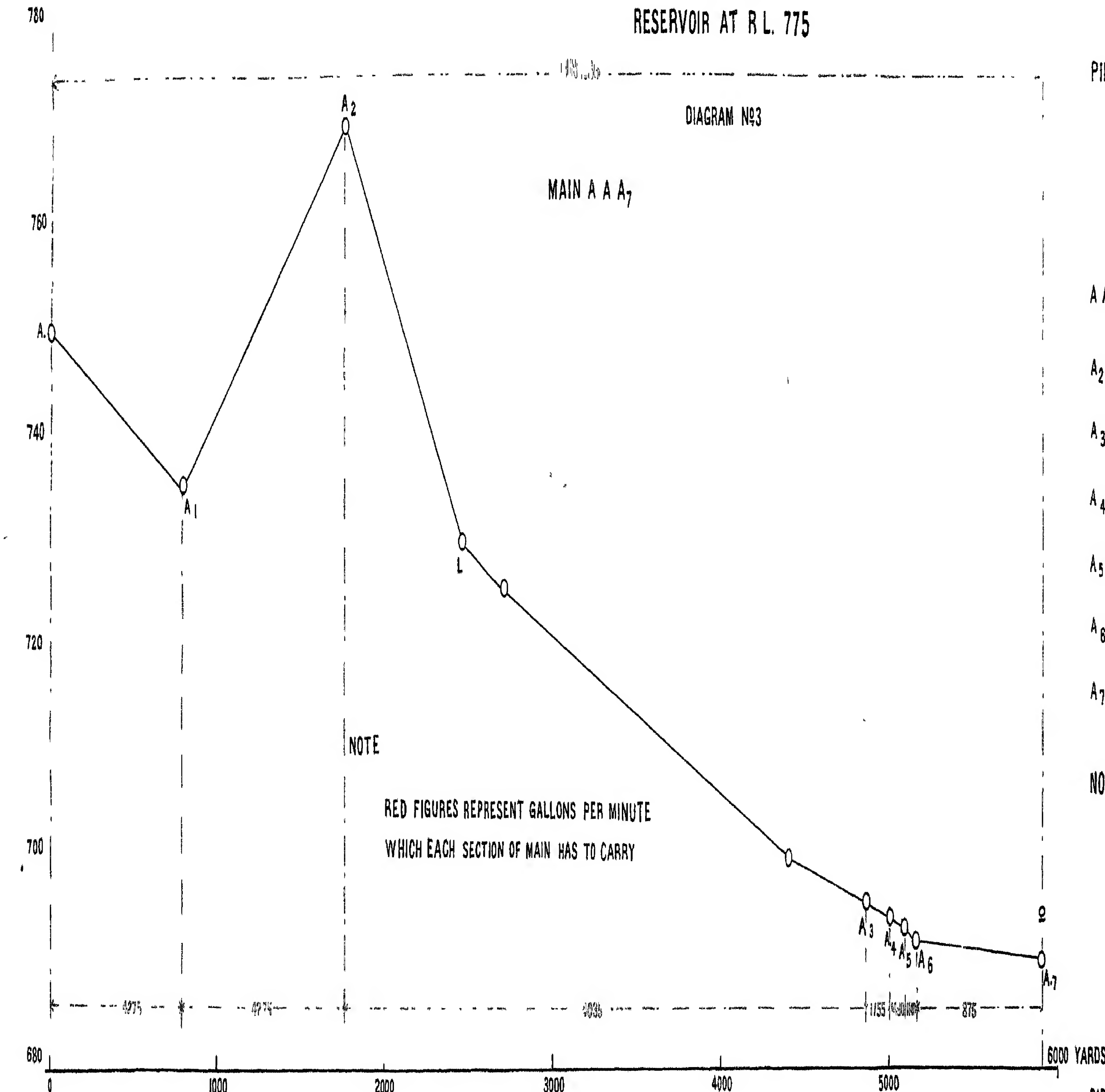
Thus for 12 hours delivery there is a *decrease* in capital cost of Rs. *13,430* and an *increase* in recurring expenditure of Rs. *41,250*.

For a 24 hours delivery there is an *increase* in capital cost of Rs. *55,176* and an *increase* in recurring expenditure of Rs. *48,453*.

(*Note.*—The distributing mains have been assumed not to be increased in length, bu actually they are longer and including this item, the debit balance by raising the reservoir is even greater.)

It is therefore clear that no economy will be effected by placing the reservoirs at a higher level than R. L. 750, which level is the lowest that the beds of the reservoirs can be in order to admit of efficient command over the area to be irrigated.

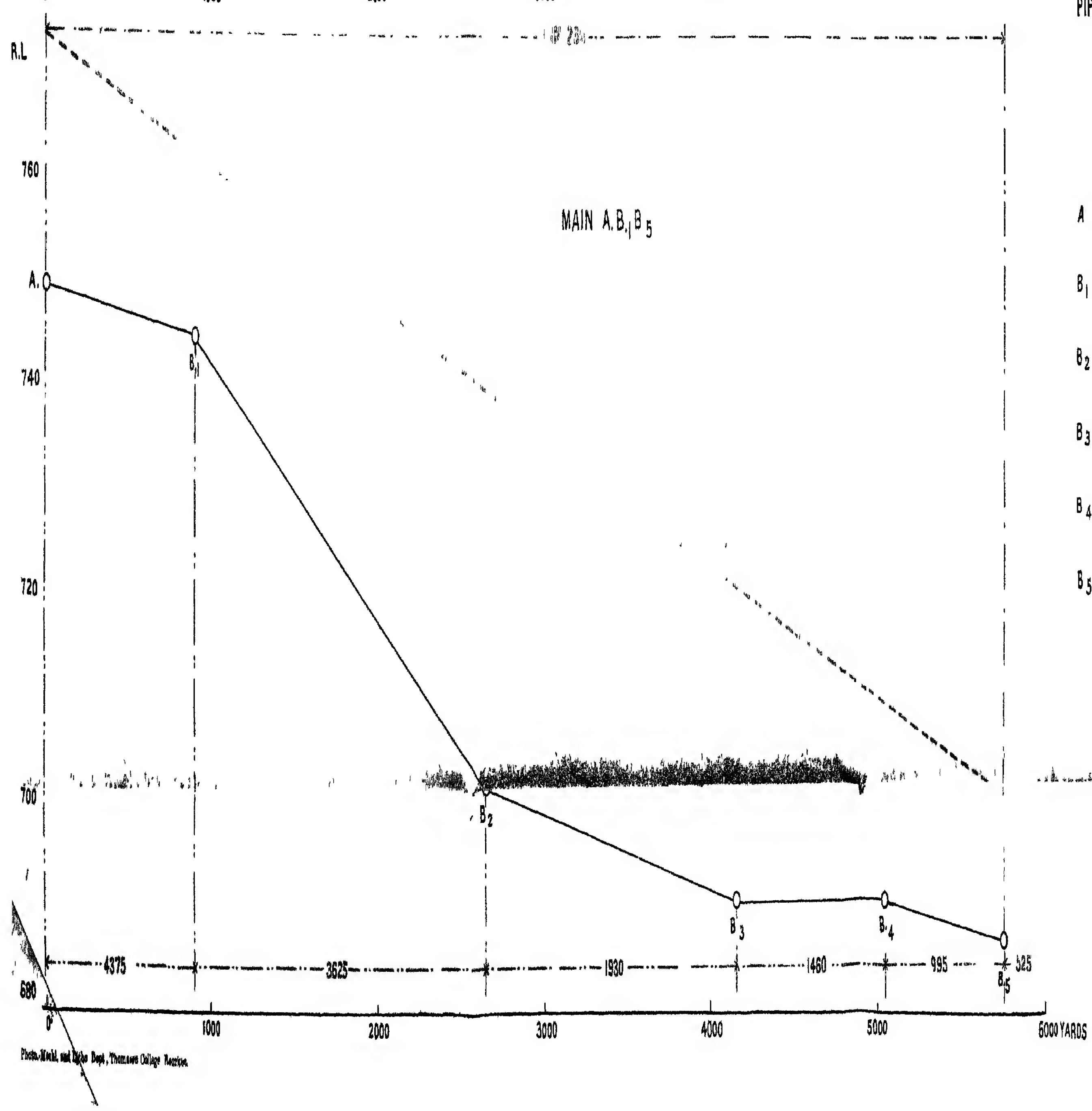
DIAGRAMS AND CALCULATIONS SHOWING HYDRAULIC GRADIENTS AND SIZES OF PIPES IN DISTRIBUTING MAINS WITH BED LEVEL OF RESERVOIR AT R L. 775



PIPE	DISCHARGE TO BE CARRIED				HYDRAULIC GRADIENT	SIZE OF PIPE	
	GALLONS PER MINUTE		C FT PER MIN				
	12 HRS DEL	24 HRS DEL	12 HRS DEL	24 HRS DEL		12 HRS DEL	24 HRS DEL
A A_2	4275	2138	684	342	1 IN 236	21"	17"
$A_2 A_3$	4035	2018	646	323	1 IN 236	21"	16"
$A_3 A_4$	1755	878	281	140	1 IN 236	16"	12"
$A_4 A_5$	1490	745	238	119	1 IN 236	14"	11"
$A_5 A_6$	1140	570	182	90	1 IN 236	13"	10"
$A_6 A_7$	875	438	140	70	1 IN 236	12"	9"
A_7	525	263	84	42	1 IN 300	10"	8"

NOTE

SIZES OF PIPE ARE TAKEN FROM "TABLES AND DIAGRAMS BY W. SANTO CRUMPS AND C. ERNEST BRUGES"



PIPE	DISCHARGE TO BE CARRIED				HYDRAULIC GRADIENT	SIZE OF PIPE	
	GALLONS PER MINUTE		C FT PER MIN.				
	12 HRS	24 HRS	12 HRS	24 HRS		12 HRS	24 HRS
A B_1	4375	2188	700	350	1 IN 230	22"	17"
$B_1 B_2$	3625	1813	596	298	1 IN 230	20"	16"
$B_2 B_3$	1930	965	309	155	1 IN 230	16"	12"
$B_3 B_4$	1460	730	234	117	1 IN 230	14"	11"
$B_4 B_5$	995	498	159	80	1 IN 230	12"	10"
B_5	525	263	84	42	1 IN 300	10"	8"

G.E. SOPWITH LT. R E,
OFFICER ON SPECIAL DUTY
HOME DEPARTMENT DELHI.

Photo.-Litho. and Litho Dept., Thomason College Roorkee.

Photo October, 1912.—No 9463 15

APPENDIX D.

Schedule of rates used in this estimate.

DESCRIPTION OF WORK.	Rate.
(1) Pumps, and buildings connected therewith ...	Rs. 650 per H. P.
Note—The actual P. H. required has been calculated, 25 per cent added to allow for slip and mechanical disadvantage and 650 per H. P. allowed for this, with further 50 per cent added to this total for spare sets.	
(2) Pipes, including laying	Rs. 8 per cwt. and add 10 per cent for breakages.
(3) RESERVOIRS.	
(*a*) Excavation in rock	Rs. 20 per cent c. ft.
(*b*) Lime concrete	Rs. 25 per cent c. ft.
(4) Power	Anna 1 per H. P. hour.

APPENDIX E.

Forecast of yearly expenditure.

Necessity for early laying down of irrigation plant.

1. As progress in the planting of trees, laying out of parks, etc., depends almost solely on the water-supply available, the laying down of the irrigation plant is one of the most urgent matters, that should engage the attention of the Engineers, concerned with the construction of the New Capital.

Dates for tenders for plant.

2. To ensure the earliest possible supply, the project should be worked out immediately the lay out is finally sanctioned, so that plans and specification may be in the hands of the Secretary of State by April 1st, 1913, and tenders accepted by him by June 1st, 1913.

Programme of delivery of plant.

3. There will be 3 sets of pumps, and of these two sets could probably be delivered within 15 months of the acceptance of tenders, or say at the end of August, 1914.

The pipes required weigh some 20,000 tons, so that the shipping of these would occupy time, even if this quantity is in stock. The greatest difficulty in quick delivery will be experienced with the pipes of large diameter, especially those of the duplicate rising main (33″ pipes) as, owing to the difficulty in securely lashing large pipes on board ship, shippers will only accept a small quantity in each ship. The rising mains alone weigh nearly 5,020 tons each. It is not therefore at all likely that a complete single rising main, with sufficient piping of other sizes to enable irrigation to be done over a considerable area will be delivered and laid before the end of March 1915. April 1915, *i.e.*, two years from date of calling for tenders in England should therefore be taken as the earliest date from which a piped irrigation supply can start working over a portion of the area, and the working plant would consist of one set of pumps, with one set spare (giving 50 per cent of the total final supply required), a single rising main and a fair proportion of the distribution system.

The remaining plant would be delivered and laid down in the years 1915-16, and 1916-17, and the forecast of expenditure is based on these assumptions.

4. In the meanwhile, *i.e.*, up till April, 1915, the cultivation of trees, etc., must be carried out by some temporary

Forecast of expenditure year by year.

Year.	In England.	In India.	Total.
	Rs.	Rs.	Rs.
1912-13	*Nil*	*Nil*	*Nil*
1913-14	9,01,612	3,00,538	11,02,150
1914-15	11,23,834	5,15,643	16,39,477
1915-16	5,01,917	1,50,269	7,12,186
1916-17	4,50,806	1,50,268	6,01,074
Total ...	30,38,169	11,16,718	41,54,887

G. C. B. P. Simla.—No. 708 H. D.—14-11-12.—55 —M.W.

ESTIMATE No. IV.

Domestic Water Supply ... ... Rs. 13,56,044.

708HD

ESTIMATE NO. IV—DOMESTIC WA.ER SUPPLY.

Report dated 12th September 1912 by Mr. H. E. Parker, assistant sanitary engineer, on the probable cost of domestic water supply.

LIST OF CONTENTS.

Paragraph 16. Points on which orders are required.

„ 17. Summary of points referred for orders.

„ 18. Programme of work.

Estimate.

Estimate of cost of domestic water supply.

Proportion chargeable to New Capital, cantonment and indian city extension.

Appendices.

A. Supply to different classes of suburbs.

B. Estimated quantity of water supply.

C. Areas provided in the lay out.

D. Details of distribution piping.

E. Schedule of rates used.

Map 4″ = 1 mile of New Capital. Showing arrangement of pipes &c. (Plan No. V in a separate cover.)

Report dated 12th September 1912 by Mr. H. E. Parker, assistant sanitary engineer, on the probable cost of domestic water supply.

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1. Quantity of water to be provided.

In order to estimate the quantity of water to be provided for the new capital, the population to be supplied has been estimated by taking the number of residences &c., as given in the schedule of areas, see Appendix A, and allowing for the probable population of europeans and indians respectively in each residence.

The figures for population allowed for are given in Appendix B, attached herewith, and amount to 5,000 Europeans and 40,000 Indians.

The quantity of water likely to be consumed by the above population has been taken as 30 gallons per head per day for europeans and 15 gallons per head per day for indians.

The quantities being made up as follows.

Europeans; supply per head per day—

Cooking	¾ gallon.
Drinking	¼ "
Ablution	10 gallons.
Share of washing utensils	3 "
Share of washing clothes	3 "
Water closets	6 "
Unavoidable waste	2 "
Horses	5 "
	30 gallons.

Indians; supply per head per day—

Cooking	¾ gallon.
Drinking	¼ "
Ablution	6 gallons.
Share of washing utensils	3 "
Share of washing clothes	3 "
Unavoidable waste	2 "
	15 gallons.

In this estimate of water consumption no allowance has been made for road watering, provision for fire extinction, flushing sewers or flushing latrines, as I am assuming that for these purposes unfiltered water from the irrigation supply will be used.

I do not propose to use unfiltered water for flushing water closets inside residences, but only for flushing outside latrines and privies, as I am averse to putting two different supplies of water, one pure and the other impure,

inside a bungalow owing to the danger of the pipes for drinking water being connected to the unfiltered water pipes.

From the Sanitary Engineers to the Punjab and the United Provinces annual reports the average consumption of water in gallons per head per day in towns, provided with a pipe water supply, and with a population principally indian, is as follows:—

> Delhi 9·83, Lahore 11·0, Ambala 7·02, Amritsar 4·21, Agra 12·44, Allahabad 12·38, Benares 19·54, Cawnpore 18·03, Lucknow 7·84, Meerut 6·97. Average, 10·96,

say 11 gallons per head per day; but the above supply is possibly supplemented by the indians by drawing water from wells.

From the above figures it would appear that a supply of 15 gallons per head per day for indians is ample.

In the above mentioned towns the supply of 15 gallons is only exceeded in two cases namely at Benares and Cawnpore, the latter is a large manufacturing town and uses nearly* ¼ of its supply for manufacturing and irrigation purposes; the former is a sacred place, and probably has to provide water for a large number of pilgrims who are not included in the population as given by the census returns.

*Since writing this report I have been informed that this is incorrect and that only about 5 per cent of the supply is used for these purposes.

In addition to the supply required as obtained from the figures for population water must be provided for special purposes for which no figures of population can be given,—*e.g.*, secretariats and other offices, hospitals, dairies, conservancy, markets, shops, schools and clubs &c.

To meet the demand from the above sources assumed quantities of water have been taken.

In the case of Government House the supply has been based on figures of actual consumption at Viceregal Lodge, Simla, an extra amount being allowed on to these figures to cover possible variation owing to the water in Simla being used very economically on account of its high cost.

For working out the sizes of distribution pipes required in the new capital, the average supply per acre has been worked out for different classes of suburbs by taking the acreage of the different suburbs and dividing the water supply for this class by its acreage. See Appendix C.

The quantity required for the indians city extensions is based on the estimated population of these extensions, that required for cantonments being obtained from the Army Department note on this subject. Provision has been made in the calculations for sizes of engines and pumps &c., for the supply to the indian city extension and to the cantonments on the assumption that all the water will be drawn from the one source, the indian city and the cantonments paying towards the capital cost and maintenance charges proportionally to their consumption.

2. Scope of project.

The present project deals only with the domestic water supply, and as far as possible only with that part of the domestic supply which is required for the part of the city occupied by Government, as apart from the cantonment and extensions of the indian city. The two latter supplies have however not been lost sight of and the sizes of engines, filters &c., where the same plant will be used, have been made sufficiently large to deal with the whole supply.

The quantity of water required for the three sections of the new capital is estimated to be as follows:—

New capital	...	...	...	1,000,000	gallons per day.
Cantonment	...	...	...	250,000	„ „ „
Indian city extensions		...	...	750,000	„ „ „
		Total	...	2,000,000	gallons per day.

It is proposed to pump the above quantity of water from the river Jumna above the city of Delhi to high ground on the Ridge south of Delhi, the supply for the new capital being drawn off *en route*. From the Ridge the supplies for the cantonment and indian city extensions will gravitate to their destinations.

3. General description of project.

In this project it is proposed to draw the water, required for domestic purposes for the new capital, from the river Jumna at the existing pumping station above the Metcalfe House, to pump it into settling tanks from which it will gravitate through filter beds and clear water tanks to the main pumps, it will then be pumped through the rising main to the distribution system for the new capital and on to storage reservoirs, designed partly to balance the supply and demand, and partly to act as storage tanks for the water required in the new cantonment and extensions of the indian city.

4. Site of intake.

The site of the intake proposed in this project is the same as that now used by the existing waterworks of Delhi city, but before detailed estimates are got out I think other sites ought to be considered.

The reason for adopting this site is that it may be possible to reduce the expenditure on establishment, if the head works are located at the same site as the present city works, as the supervision for both supplies can be carried out by the same staff and also the workshops for repairs to plant will be the same, although the engine houses and other works may have to be separate.

I think a better site for the headworks might be found near Wazirabad where the river would not be so liable to contamination as at the present intake.

The site proposed is two miles higher up the river than the present site, consequently the cost of the engines and rising mains would be increased, also the establishment would be entirely separate from that now employed on the existing works, if this alternative site is adopted.

The villages of Chandrawal and Wazirabad are situated within two miles above the present intake, the outlet from the Najafgarh drainage cut also flows into the river about ½ mile above Wazirabad. The temporary quarters for the indian clerks working in the Secretariat have been built between the Ridge and the Najafgarh cut, and it is conceivable that, whatever precautions may be taken to deal with the drainage of these villages, there will be danger of pollution from them. It has been shown that the hot weather discharge of the river has on occasions, fallen as low as 64 cusecs. (See file dealing with the river Jumna).

At the time the existing waterworks were built it is possible the discharge was never as low as this, and therefore the risk of dangerous pollution was less owing to the greater volume of water, it was also intended to draw the water from infiltration wells. and not direct from the river, and the latter course was only adopted after the supply from the infiltration wells had been found to be inadequate.

The site I would suggest for consideration for the intake works is to the north of Wazirabad, where the Ridge ends at the river. This site is above the two villages mentioned, though it is not above the outlet of the Najafgarh drain. The cost of diverting this drain to the south of Wazirabad would not be great as there is a low neck of land between Wazirabad spur and the main ridge, which has obviously at one time been either the outlet for the drainage of the country, or a channel of the main river.

5. Unfiltered water pumping station, estimated to cost Rs. 2,66,280.

(*a*) River training and protective works, estimated to cost Rs. 1,00,000.

At the intake works it may be necessary to protect the bank of the river from erosion so as to prevent damage to the engine house; it may also be found necessary to build training works in order to keep the river in its present course and thus save annual expenses on digging channels to lead the water to the intake.

A sum of Rs 1,00,000 has been allowed in the estimate to cover these works, if required.

For the actual intake works I propose to build a wall on the bank of the river to carry the supply pipes and also to carry duplicate screens etc., to strain out sticks and large articles floating in the river: the screens will be provided in duplicate in order that one at a time may be taken out to be cleaned, a bridge and the necessary tackle for raising and cleaning the screens will also be provided.

(b) Intake, estimated to cost Rs. 40,000.

The supply pipes will be built into the intake, well below low water level of the river, and will be provided with a strainer to catch anything not strained out of the water by the screens. These pipes will lead from the intake to the suction well below the engine house.

(c) Supply pipes, estimated to cost Rs. 8,480.

(d) Suction well estimated to Rs. 8,000.

I propose to build the engine house about 50 yards away from the river bank in case of damage and erosion of the banks in spite of the protective works.

The engine house will contain the boilers, engines and pumps necessary for raising the river water from the river to the purification works; and in addition godowns, coal stores and dwelling houses for the working staff must be provided.

(e) Engines and pumps, boilers, etc., and all buildings estimated to cost Rs. 77,400.

In this scheme the engines and pumps and rising mains have been provided of sufficient capacity to deliver the whole supply required per day in 16 hours, this is in accordance with water works practise in India, as it allows for a reduction in the amount of spare power which must be provided in case of accident, and also allows for the supply to be pumped by two shifts of engine drivers and stokers instead of the three shifts, which would be required if the daily duration of pumping was extended beyond 16 hours.

When the final project is worked out for the approved lay out of the new capital, the saving in cost of providing engines and pipes large enough to deliver the supply in 24 hours, instead of 16 hours, should be worked out and compared with the greater cost of providing extra spare power in the engines and pumps, in case of accident, and the larger establishment for driving the same for 24 hours per day instead of 16 hours.

The supply of water required per day for domestic purposes has been shown to be 2,000,000 gallons at the site of the new capital and cantonments etc., a larger supply than this must however be provided at the settling tanks to allow for evaporation and for waste of water after cleaning filter beds.

It is probable that one filter bed will always be out of action for cleaning, and that for some days after it has been cleaned the water will have to run to waste until the purifying bacteria are working satisfactorily and the filtered water is fit for use.

Bligh, in his book on the practical design of irrigation works, states that the loss by evaporation is 0·4 inches per day in the hot weather and 0·2 inches per day in the cold, and that the loss by absorption in well designed works is about one half of that by evaporation. Taking the worst case the loss by evaporation will be 0·4 inches per day over the area of the settling tanks and filter beds, as we may assume, that these settling tanks, being lined with puddle and concrete, and the filter beds, being built of masonry, will be water tight.

The rate allowed for filtration in this project is 30 gallons per square foot per day, therefore the area required to filter 2,000,000 gallons per day is 66,667 square feet. Assuming that this area is divided up into 5 units and that a 6th is allowed spare for use when any of the units are laid up for scraping or cleaning, the total area of filter beds for filtering the 2,000,000 gallons will be 80,000 square feet, and the loss by evaporation from this area will be 16,667 gallons per day.

The amount which will run to waste from the sixth filter after it has been scraped, and before it is put into use again = 13,333 square feet at 30 gallons per day = 400,000 gallons per day.

The amount which must be delivered to the filters from the settling tanks must therefore be:—

For supply	...	...	...	2,000,000 gallons per day.
For loss by evaporation		...	...	16,667 „ „ „
For wastage	...	...	...	400,000 „ „ „
				2,416,667 gallons per day.

It is proposed to provide the settling tanks in three units, each capable of holding one day's supply, the water will be pumped into these tanks in rotation, each tank being filled in one day, resting full on the 2nd and being emptied on the 3rd day.

The depth proposed for these tanks is 12 feet and the slope of the side slopes 3 to 1.

Assuming a top water area of 46,000 square feet for each tank the loss by evaporation will amount, at 0·4 inches per day, to 9,583 gallons or 28,750 gallons from the three tanks.

The supply required to the filter beds has been shown to be 2,416,667 gallons, therefore the total supply required will be 2,445,417 gallons.

The capacity of a tank of the above top water area and depth etc, is 2,483,400 gallons.

For the purposes of this estimate the above capacity may be adopted.

The unfiltered water plant must therefore be capable of delivering 2,445,417 gallons per day of 16 hours *i.e.*, 2,547·3 gallons per minute or 6·793 cusecs.

Assuming a velocity in the rising main of 3 feet per second the area of this main must be 2·264 square feet = 326·02 square inches. Diameter of pipe $20\frac{5}{8}$ inches, say 21 inches.

For the supply-pipe to the suction well allow for a loss of head in the 50 yards of 6 inches, and adopt a 36 inch pipe in duplicate and a lower velocity than the above 3 feet per second to insure a full supply to the pumps. For the rising main to the settling tanks I have adopted the above figure for the diameter, namely 21 inches.

I am assuming that the length of the rising main to the settling tanks will be 500 yards, and that the static head will be 40 feet, including suction and delivery.

The total head against which the unfiltered water pumps will have to work is found from the following formula $H = \frac{G^2 \times L}{(3d)^5}$.

Where G=gallons discharged per minute.

L=Length of rising main in yards.

D=Diameter of rising main in inches.

And $H = \frac{2547{\cdot}3^2 \times 500}{(3 \times 21)^5} = 3{\cdot}27$, say 4 feet.

Total head=40 + 4 = 44 feet.

Horse power of engines and pumps= $\frac{2547{\cdot}3 \times 10 \times 44}{33000}$ =33·97.

Add 25 per cent for loss of efficiency ... 8·49

42·46, say 43 H. P.

The plant is to be provided in three units of which any two are to be capable of raising the whole quantity required per day, in 16 hours. Therefore total horse power = $64\frac{1}{2}$.

(f) Rising main, estimated to cost Rs. 22,400.

The thickness of a 21″ pipe to withstand a head of 44 feet is fonnd from the formula $t = \cdot 000054\ H.\ d. + \cdot 15\ \sqrt{d}$.

where H and d are as before, and t is the thickness in inches. The thickness from the above works out at 0·74 inches, say $\frac{49}{64}$″, and the weight of a pipe 12 foot long of this thickness is 19 cwts, or 1·583 cwts per foot.

1,500 feet at 1,583 cwts per foot	= 2375 cwts.
Add 7 per cent for bends and special pipes	166 ,,
	2541 cwts.
Add 10 per cent for breakage, variation in weight of pipes, possible rock cutting etc.	254 ,,
	2795 cwts.
Say	2800 cwts.

The weight of the 36″ supply pipe is taken at 36 cwts. per 12 foot length *i.e.*, 3 cwts per foot and the length of the duplicate pipe is

300 feet, total weight	900 cwts.
Add 7 per cent for bends and specials ...	63 ,,
	963 cwts.
Add 10 per cent for breakage, variation in weight of pipes etc.	96 ,,
	1059, say 1,060 cwts.

(e) Valves, meters etc., estimated to cost Rs. 10,oco.

Valves, meters etc.. to control and measure the supply must also be provided.

6. Purification plant, estimated to cost Rs 2,64,500.

The purification plant will consist of settling tanks, filter beds, clear water reservoirs, sand washers and the necessary pipes, drains, valves and meters or measuring the work done by each filter bed etc.

(a) Settling tanks, estimated to cost Rs. 86 000.

There are two alternative ways of building the settling tanks, they may be either arranged as intermittent tanks or as continuous ones.

In the former case the tanks will be built in three units each capable of holding one days supply, plus the losses due to evaporation and wastage from the filters in cleaning and restarting them subsequently; each tank will be filled in a day, it will rest full on the 2nd day, and be emptied on the 3rd day. The tanks will thus, assuming that all pumping is done in 16 hours per day, have 32 hours absolute rest.

At certain times of the year, when the quantity of silt in the river is great and very fine in character, this period of rest will not be sufficient without resorting to chemical or other artificial method of settlement, but this method gives a period of absolute rest which is absent in the other method.

In the second method where continuous tanks are adopted the water would be continually being pumped into the tanks, and would be moving through them with a very slow velocity, $\frac{1}{14}$ to $\frac{1}{20}$ of an inch per second, and would be drawn off at about the same level as it entered; the tanks being so designed that the water would take from 15 to 20 hours to pass through them.

The disadvantages of the first method are that the water has to be raised 12 feet higher by the pumps than in the latter case, thus causing a higher first

cost of the engines and pumps and a greater cost of maintenance; also the silt which has previously been deposited in the tanks is partially stirred up with every new filling of the tanks and also in a less degree with the drawing off.

Larger settling tanks and clear water reservoirs also have to be provided.

The advantages are that the filters work continuously and therefore more favourably than in the other case and also the area of filter beds is less than in the other case.

In the second case the disadvantages are that the area of filter beds has to be increased as the continuous tanks only discharge water as long as the pumps are delivering water into them, also the filter beds work more satisfactorily, if they are kept continuously at work after having been started, until they are laid up for cleaning.

The advantages are a lower head for the engines to pump against owing to their being very little height lost in the tanks; it is also not necessary to provide storage for the filtered water during the hours when water is not being pumped.

In this project I have adopted the first of the two alternatives. Water will be admitted at top water level of the tanks and will be drawn off by means of a floating arm which draws water from one foot below surface level.

The depth of water to be drawn off from each tank will be 12 feet, but an additional depth of 3 feet will be allowed for deposit of silt.

The supply and draw off pipes will be so arranged that any tank can be filled or emptied at one time, or so that water can be passed direct to the filter beds without going through the settling tanks; scour pipes and drains will also be provided for emptying the tanks for silt clearance.

The tanks will be built partly in excavation and partly in embankment, the amount of excavation being so determined that the quantity of excavated material from these tanks, plus the material excavated from the filter beds and clear water reservoirs, will be equal to the quantity of material required for forming the banks.

A road 12 feet wide will be formed on top of the banks and the side slopes will be made 3 to 1 on the inside and 2½ to 1 on the outside, unless the material of which the banks are formed is sufficiently good to allow of steeper slopes being formed. The banks on the inside will be puddled with clay puddle to make them water tight and will be covered with stone or concrete slabs on the whole of the face; the floor of the tanks will also be concreted and given a slight slope to the scour pipes and drain. The surface area of each tank will be 46,000 square feet and the depth to lowest draw off 12 feet, the total depth to floor being 15 feet; the 3 to 1 slope will only be carried down to lowest draw off level, below this level the sides will be formed of a dwarf wall, battered 1 to 8.

The total capacity of each tank assuming the surface dimensions are 230 feet by 200 feet will be 2,862,600 gallons, or a total capacity in the three tanks of 8,587,800 gallons. Say 8,600,000 gallons.

(b) Filter beds, estimated to cost Rs 80,000.

In the present project I have allowed for the ordinary type of slow sand filter bed and have adopted a rate of filtration of 30 gallons per square foot per 24 hours. When the detailed project is prepared the question of adopting rapid filtration, by the Jewell, or other mechanical filter, or rough filtration, previous to the slow sand filtration, by the Puech Chabal or other similar system of filtration, will be considered.

The area of sand filters required for purifying the water supply will be $\frac{2,000,000}{30}$ =66,667 square feet, say 5 filters each 13,333 square feet in area and allow a 6th filter, as spare for those times when one of the others is being scraped and cleaned. Total filter area 80,000 square feet.

(c) Clear water reservoir, estimated to cost Rs. 35,000.

A clear water reservoir must be provided of sufficient capacity to store the discharge from the filter beds during the hours when the pumping engines are not working, *i.e.*, for 8 hours in every 24. The filter beds are to be designed to filter at the rate of 30 gallons per square foot

per 24 hours, and their area is to be 66,667 square feet therefore they will discharge at the rate of 83,333 gallons per hour.

The capacity of the clear water reservoir must therefore be 666,664 gallons, say 700,000 gallons.

These reservoirs should be provided in two units each of 350,000 gallons capacity, to allow for cleaning when necessary ; allowing a depth of 10 feet the area of each reservoir must be 5600 square feet, say 80 feet long by 70 feet wide.

(d) Pipes, valves, meters, drains, etc., estimated to cost Rs. 50,000.

Overflow pipes and drains must be provided at top water level of all settling tanks, filter beds and clear water reservoirs, and also scour pipes from the floor level of each tank etc., connected to the above mentioned drain.

Byepass pipes must be provided so that the water can be passed round any of the tanks etc, direct to the engines, if required. The necessary valves and meters for measuring the supply must also be provided.

(e) Sandwasher, estimated to cost Rs. 3,500.

A sandwasher for washing the dirty sand removed from the filter beds and the fresh sand brought to replace sand lost by wastage, etc, must be provided.

(f) Tramway, estimated to cost Rs 10,000.

Tramways for carting sand from the filter beds to the sandwasher, etc., must also be allowed for.

7. Filtered water pumping station, estimated to cost Rs. 3,39,000.

Under this head the engines and pumps, boilers, etc., engine and boiler house suction well, workshop, godowns, coal store and buildings for accommodating the working staff are taken. It is proposed to pump the water required for consumption from this point direct to the new capital distribution and to service reservoirs on the ridge for supply to the indian city and to the cantonments. The service reservoir supplying cantonments will also act as a balancing reservoir to supplement the discharge from the pumps, when the new capital is drawing its maximum supply and the pumps are delivering the normal supply only.

The quantity to be pumped per day of 16 hours by this installation is 2,000,000 gallons=2083·3, say 2085, gallons per minute = 5·56 cusecs.

Allowing a velocity of 3 feet per second in the rising main, the area of this main up to the take off to the indian city will be 1·853 square feet = 266·8 square inches.

The diameter of pipe required to give this area of section is 18½ inches, say 18 inches.

The length of the rising main from the pumping station to the offtake for the indian city is 13,860 linear feet. The head due to friction in this length is found from the formula $H = \frac{G^2 \times L}{(3d)^5}$, and amounts to 43·75 feet say 44 feet.

Beyond the indian city offtake the quantity to be discharged will be 1,250,000 gallons per day of 16 hours = 1,302·1 gallons per minute, say 1305 = 3·48 cusecs.

The area of the pipe required for this discharge will be 1·16 square feet =167·04 square inches, and the diameter of pipe to give this area will be 14⅝ inches, say 15 inches.

The length of this pipe will be 21,780 linear feet, and the head due to friction, by the same formula as before, will be 66·97 feet, say 67 feet.

The pipe to the indian city extensions will be designed so that the head due to friction will be less than the above 67 feet, therefore the total head due to friction will be 44 + 67 = 111 feet.

It is proposed to build the service reservoir for the new capital and cantonments at the highest point of the ridge south of Delhi namely at R. L. 865·5.

The low water level at the intake on 26-4-12 was 663·0, but I am assuming that the river may fall as low as 660·0.

The unfiltered water engines have been designed to raise the water 40 feet, but of this height about 12 feet will be used in the settling tanks, $7\frac{1}{2}$ feet in the filters, 10 feet in the clear water reservoir, and say 5 feet in the supply and outlet pipes, total 34·5 feet.

The water level in the filtered water suction well will therefore be 655·5 and the total static head will be 200 feet. Adding the friction head the total head against which the filtered water engines will have to work will be 311 feet.

The horse power of the plant will therefore be $\dfrac{2085 \times 10 \times 311}{33000} = 196{\cdot}5$

Add 15 per cent for loss of efficiency ... ... 29·5

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In the case of the unfiltered water engines 25 per cent was allowed for loss of efficiency, as these engines will have to pump water drawn direct from the river and at certain times of the year full of dirt and silt, also the horse power of these engines is low, the losses by slip will consequently be greater than in the filtered water plant.

The plant is to be provided in three units any two of which are to be capable of pumping the whole supply required per day in 16 hours, the third engine and pump being in case of break down on either of the other sets. Therefore the total Horse power required will be 339.

For this supply I propose to adopt a steam plant, in preference to either a gas or oil plant, for both the unfiltered and filtered water plants. as I believe it will be found cheaper and more efficient, in the long run, than either of the other two. The plant I propose would consist of Babcock and Willcox, or other approved, water tube boiler, fitted with Green's economiser, steam superheater, chain grate stoke and the necessary driving engines, feed pumps, etc., Worthington, or other approved, type of Triple expansion, surface condensing pumping engine direct coupled to plunger pumps, complete with all suction and delivery pipes inside the engine house, air vessels, foot valves and strainers, etc.

The plant will also have all necessary accessories such as overhead travelling crane, oil tanks, spanners, gauges, etc., etc., and the makers supplying, the above will be required to guarantee the required delivery against the head, including suction, delivery and friction, with a stated steam and coal consumption using good indian coal.

8. Rising Main, estimated to cost Rs. 4,63,800.

The rising main will be laid in as nearly a straight line as possible from the pumping station to the site of the new capital.

The supply for the indian city extensions will be taken off the main at the Qadam Sharif, on the present road to the Kutab ; the main south of Paharganj will be laid in a south-westerly direction along one of the roads of the new capital until near Talkathora, where be will given a bend in a westerly direction and taken up to the site of the service reservoir. The water required for the new capital will be drawn from the rising main along the length between Paharganj and Talkathora.

(a) 18" main to offtake for city extension, estimated to cost Rs. 2,19,520.

(b) 15" main from offtake to city extension to service reservoir, estimated to cost Rs. 2,29,280.

The diameters required for the pipes to give the required discharge, with a velocity of 3 feet per second, have already been calculated, namely 18 inches and 15 inches, their lengths are respectively 13,860 feet and 21,780 feet.

When the final detailed project is worked out the sizes and costs of pipes and pumps, and the maintenance charges with higher and lower velocities than 3 feet per second will be worked out, and the most economical size of pipe and pumps adopted, but for the purposes of this estimate the velocity of 3 feet per second has been taken.

The length of pipe required for supplying the reservoir for the indian city extensions, which I propose to locate on the high ground near the

Idgah, is 4,785 feet, and the diameter for a velocity of 3 feet per second 12 inches.

The rising main must be made thick enough to withstand a head of 300 feet on the 18" section, and of 200 feet on the 15" section. Using the formula $t = \cdot000054\ Hd. + \cdot15\sqrt{d}$, the thicknesses work out as follows :—

18" to stand 300 feet = 0·928" = ... $\frac{15}{16}$"
15" to stand 200 feet = 0·743" = ... $\frac{3}{4}$"

The weight of a cast iron barrel 18" inside diameter and $\frac{15}{16}$" thick, with cast iron at 0·2604 lbs. per cubic inch, is 1·557 cwts. per foot, and the weight of one 15" inside diameter and $\frac{3}{4}$" thick is 1·035 cwts. per foot.

Adding 8 per cent to cover the weight of the pipe sockets, the weight per foot of pipes 18" diameter $\frac{15}{16}$" thick and 15" diameter $\frac{3}{4}$" thick is 1·682 and 1·118 cwts. per foot respectively.

Total weight of 18" pipe line 13,860 feet long at 1·682 cwts. per foot	= 23,312·5 cwts.
Add 7 per cent to cover the extra cost of bends and specials	= 1,631·9 "
Total	24,944·4 cwts.
Add 10 per cent to cover broken pipes, extra cost of rock cutting, etc.	2,494·4 cwts.
Total 27,438·8 cwts. Say	27,440 cwts.
The total weight of the 15" pipe line 21,780 feet long at 1·118 cwts per foot is	= 24,350 cwts.
Add 7 per cent to cover the extra cost of bends and specials	= 1,704·5 cwts.
Total ...	26,054·5 cwts.
Add 10 per cent to cover broken pipes, extra cost of rock cutting, etc.	2,605·5 cwts.
Total ...	28,660 cwts.

(c) Valves, meters, etc., estimated to cost Rs. 15,000.

Valves, meters, etc., for controlling and measuring the supply will be provided as required.

9. Service reservoir, estimated to cost Rs. 62,500.

It is proposed to build two service reservoirs, one from which the supply required for the indian city will be drawn, and the other to supply the cantonments and also to act as a balancing tank on the supply to the new capital.

The present estimate has nothing to do with the first of the above.

It is proposed to make the capacity of the new capital and cantonment reservoir equal to one days' supply, namely 1,250,000 gallons, in order that there may be some water to fall back upon in case of accident at the headworks. This reservoir will be built in two compartments in order to admit of cleaning one part without stopping the supply.

10, Distributing system, estimated to cost Rs. 5,46,640.

It is proposed to draw the water for distribution from the rising main to the service reservoir. The diameter of this main has however been kept constant throughout its whole length, and not reduced according to the quantity of the supply drawn off, because, when little or

no water is being drawn from the main, the whole quantity will be pumped straight to the service reservoir.

The sizes of pipes in the distribution system have been calculated large enough to supply one half the total daily supply in six hours, this is in accordance with experience on waterworks, as it is found that the demand for water is greatest in the morning and evening, and is practically nothing at all at night.

(a) Pipes, estimated to cost Rs. 4,46,640.

The size of the rising main and pumping plant have however not been made large enough to give the supply in six hours, but allowance has been made to supply the new capital from two sources, namely the pumping engines and the service reservoir, and therefore the expense of providing a rising main and engines large enough to give half the supply in six hours has been overcome.

In calculating the sizes of the distributing pipes the level of the hydraulic gradient along the length of rising main, from which the supply will be drawn off, has been taken as 865·5 ; that is to say that the water delivered from the service reservoir will keep the level of the hydraulic gradient constant.

The distributing pipes have been provided, so that, in no case shall any residence be at a greater distance than 600 feet from the water supply. Details of the sizes of the various distributing pipes are given in Appendix D. The total weight of the pipes allowed for amounts to 55,830 cwts.

The sizes of pipes and their respective lengths will have to be taken out again, when the final lay out is approved and detailed estimates are prepared, the present lay out of pipe lines having been made on the lay out for the city known as Mr. Lanchester's 2nd revised lay out.

It is proposed to provide valves on the distribution, so that any part of the distribution can be cut out without stopping the whole supply ; it is also proposed to divide the distribution up into small districts and to provide Deacon's, or other, waste detecting meters, so that any waste of water or leakage can be detected.

(b) Valves, meters, etc., estimated to cost Rs. 1,00,000.

It will be advisable to provide a telephone line from the pumping station to the service reservoir and to the city service reservoir, in order that orders may be quickly attended to and information of any damage or accident may be given, at the pumping station in time to shut down the pumps before worse damage is done. The rate charged to the Western Jumna canal for telephone lines is Rs. 26-4 per mile per annum, and Rs. 54 per instrument. Capatalising these charges at 4 per cent, the cost of telephone lines works out at Rs. 606·25 per mile and instruments at Rs. 1,350 each.

11. Telephone line, roads, etc., estimated to cost Rs. 27,660.

(a) Telephone line, estimated to cost Rs 6,060.

The length of telephone lines will be, say 10 miles, allowing for a line to the indian city reservoir, and also one to about the centre of the distribution system, and provision should be made for 6 instruments. The capital cost of the installation will therefore be :—

10 miles at Rs. 606	... Rs. 6,060
6 instruments at Rs. 1,350	... „ 8,100
	Rs. 14,160, say Rs. 14,000

An allowance should also be made for roads and fencing on the site of the pumping station. I am not allowing anything for cost of land as the land on which it is proposed to build will be charged for under a separate estimate.

(c) Roads at site, estimated to cost Rs. 10,000.

(d) Fencing site, estimated to cost Rs. 3,500.

12. General.

The prices allowed for the various items in this estimate and the percentages allowed for engines, etc , are based either on an old estimate for the Benares water works, or on figures obtained from the Hon'ble Mr. Goument, Chief Engineer to Government, United Provinces.

13. Estimated cost, Rs. 19,82,380.

Proportion chargeable to

(a) New capital, Rs. 13,56,044.

(b) Cantonment Rs. 2,00851.

(c) Indian city extension Rs. 4,25,485.

The estimated cost of the works detailed above amounts to Rs. 19,82,380. Of this sum a proportion should be charged to the cantonment water-supply and also to the supply to the indian city extensions.

The proportional charges are arrived at as follows:—the new capital requires 1,000,000 gallons, the cantonment 250,000 gallons, and the indian city extension 750,000 gallons per day, therefore the charges common to all three are divided into 8 parts of which the new capital pays for 4, the cantonment for 1, and the city extension for 3. Those items which are common to the two first only are divided into 5 parts of which the new capital pays for 4 and the cantonment for one.

The sums thus arrived at are as follow:—

	Rs.
Cantonments	2,00,851
Indian city extensions	4,25,485
Bringing the cost chargeable to the new capital to ...	13,55,044

Tools and plant and establishment have not been included in the estimate as these are being shown in a separate estimate.

14. Existing water supply.

No allowance has been made for using the existing works to supply any part of the new capital.

The works could not, without considerable alterations and additions, be made to supply the new capital, though they could be adapted to supply to some of the low lying parts of the site, and to a part of the city extensions, but as at present arranged these works could not supply the whole of the city extensions.

In the report dated 16th April 1912 on the existing water works, it is shown that the plant is capable of delivering 3,840,000 gallons per 24 hours from the unfiltered water engines, 4,340,800 gallons per 24 hours from the filters, allowing a rate of 40 gallons per square foot per 24 hours, and 6,434,800 gallons per 24 hours from the filtered water engines.

If we assume that the supply must be delivered in 16 hours, the quantity which can be pumped per day by the unfiltered engines is 2,560,000 gallons, and 4,290,000 gallons by the filtered engines, and if we take 30 gallons as the rate of filtration, the supply from the filters per 24 hours is 3.380,600 gallons. In addition to the filter beds there are a number of infiltration wells which can supply water direct to the filtered water engines, but the supply from these wells has now been condemned, and their use stopped. The supply available per day from the existing works is therefore the 2,560,000 gallons, which the unfiltered water engines can supply.

According to the census returns of 1911 the population of Delhi is 2,32,837, and consequently the maximum supply which can be delivered to this population is, approximately 11 gallons per head per day, as compared with 15 gallons per head per day allowed for indians in the new capital; the total supply available from the existing works should therefore be utilised for the existing city instead of being extended to the new capital, especially as this supply is used for road watering and drain flushing, etc., as well as for the purely domestic supply.

15. Combined scheme for domestic and irrigation supply.

In this estimate the domestic water supply has been kept entirely separate from the irrigation water supply as the latter water will be delivered straight from the river to the site of the city. It is however possible that it may be more economical, either in first cost or in maintenance charges, if the two schemes are combined, and a project on these lines is about to be drawn out for comparison.

16. Points upon which orders are required.

The following points raised in this report will require orders to be passed upon them, before the detailed project is prepared.

(a) Population.

The population allowed for in the new capital, and indian city extensions is shown in Appendix B, and amounts to 5,000 europeans and 40,000 indians in the new capital and 50,000 indians in the city extensions; the population allowed for in the cantonments is that given in the Army Department notes and amounts to 6,000 europeans and indians and 2,000 horses. Details showing how the above populations have been allocated are given in Appendix B.

It has been assumed that a certain proportion of the officers, etc., living in the new capital will be unmarried, and that the average number of europeans per residence will be 4, in the same way it has been assumed that, a certain proportion of the servants in each compound will also be unmarried, or will have their families residing elsewhere.

At the time this estimate of population was prepared the list of officials, clerks etc who were to come to Delhi was incomplete. The number of european clerks and minor officials and their families has probably been under estimated, as this class of person is more likely to have children living in the new capital than the high officials, who can more easily afford to send their children to England to be educated.

(b) Quantity of water required.

The quantity of water per head per day allowed is 30 gallons for europeans and 15 gallons for indians, on the populations shown above. These quantities are based on the quantities of water given in Parkes' Practical Hygiene, as being required.

The amounts given in the book above referred to, and those allowed in this estimate are as follows.

	PARKES' HYGIENE. Gallons per head per day.	QUANTITY ALLOWED. Gallons per head per day.	
	——	Europeans.	Indians.
Cooking	¾	¾	¾
Drinking	⅓	⅓	¼
Ablution, including sponge bath daily.	5	10	6
Share of house and utensil washing.	3	3	3
Share of laundry ...	3	3	3
Water closets ...	6	6	...
Unavoidable waste ...	3	2	2
General baths ...	4	...	...
Horses	6	5	...
Total number of gallons...	31	30	15

Parkes also states that the supply in Calcutta is 37 gallons of filtered, and 5·8 gallons of unfiltered water per head per day. It should be borne in mind that the quantity of water allowed is for purely domestic purposes and that none of it will be used for road watering, irrigation, fire extinction, main drain or latrine flushing, etc.

Allowances have been made for certain special buildings, and purposes, namely:—Government House, secretariats, clubs and race course, dairies, markets, shops, conservancy, etc., as the supply to these buildings, could not be based on any figures for population.

The supply to the secretariats has been allowed for at 25,000 gallons per day. This is probably more than will be required, and is at the rate of $4\frac{3}{4}$ gallons per head per day on 5,250, which is the total number of officers and clerks, as given in the present list of accommodation required, using these buildings. It is probable that a supply of 2 or 3 gallons per head per day will be sufficient for these buildings.

The Army Department have asked for a supply of 240,000 gallons per day, but this supply has been shown to be only sufficient for the actual garrison and makes no allowance for indian followers and inhabitants of the regimental and Sudder Bazaars, which they stated would be built. If the Ridge is afforested

(c) Afforestation of the Ridge.

it will be necessary to provide a certain quantity of water, at certain times of the year, for irrigating the area afforested.

This water could be supplied either from the irrigation scheme, or from the domestic supply.

For the greater part of the new capital it will not be necessary to pump the irrigation water to as high a level as the top of the ridge and it would be more economical to, either supply this area from the filtered water supply, or to put in small pumps to raise the irrigation water for this purpose from the reservoirs for storing the water required for irrigating the area of the site situated below the 750′ contour.

The area which may be afforested is given as 4,000 acres, but no statement as to the quantity of water, which will be required per acre per day, for watering the young seedlings is given in the report on the afforestation.

The military authorities have asked for a supply of water for domestic

(d) Cantonment irrigation.

purposes. Up to the present they have not asked for any supply for irrigation It is not proposed to pump more water in the irrigation project than will be required for the area of the new capital, and it is also not proposed to pump the greater part of the irrigation water to a sufficiently high level to control the cantonment area. In this connection the attention of the military authorities may be called to the fact that wells on the site of the cantonment are few in number, also the cultivators do not attempt to grow any crops except cattle fodder in the kharif, and only in years of good rainfall can wheat and gram be grown in the rabi.

It is probable that the reason for the small number of wells is that the subsoil water supply is not reliable on this area and therefore it is not worth the cultivators while to spend money on sinking additional wells for an uncertain supply.

Before detailed projects are prepared the Army Department should be asked to state whether they will require a supply of water for irrigation, and if so what the quantity of water required for irrigation will amount to.

If the quantity, required by the military for irrigation, is not large, it may be more economical to supply them with filtered water, instead of increasing the irrigation scheme to deal with the extra pumping required to deal with this supply.

It has been shown that the existing waterworks are capable of supplying 11

(e) Existing waterworks.

gallons per head per day to the present population of Delhi city. The existing works could be adapted to supply a portion of the new capital and the indian city extensions with water without radically changing their present supply, but

they could not be adapted to supply the whole of the new capital, or the city extensions, without very considerable alterations and additions.

If the existing works are adapted to supply a part of the new capital, it will still be necessary to provide a scheme to supply the higher parts of the new capital, and the indian city extensions, and the whole cantonments, and the cost of these works would probably be larger in proportion to the quantity of water supplied, than if an entirely new system is designed for the new capital, etc., and the existing works are used to give a larger supply to the area already controlled by them.

(*f*) Proportional charges to share holders.

In the report above it is proposed to supply the new capital, cantonments and indian city extensions with water in the proportion of 4 to 1 to 3, and to charge the three share holders with the cost of the works, relating to their supply, in the above proportions. It may however be more satisfactory to keep the whole works under one authority, and to charge a sum per 1,000 gallons supplied to the other two authorities, this charge being based on the running expenses, interest and sinking fund on capital cost and depreciation charges.

In either cases the supplies would be delivered to the two authorities at certain fixed points, and they would make their own arrangements for dealing with the supply beyond these points.

(*g*) Site of intake works.

It has been shown that the site selected for the intake in the above scheme namely the existing works for water supply of Delhi, is liable to contamination from four sources, in addition to two other sources which are common to all indian rivers, namely, the habit of indians squatting on the banks of rivers and washing their clothes in them, and the risk of pollution from corpses floating in the river, and it is suggested that a different site should be selected for the intake.

Three of the sources of contamination could be removed, namely the villages of Chandrawal and Wazirabad, which could both be dismantled and evacuated, and the colony of secretariat clerks, which will presumably cease to exist when the new capital is built.

The medical and sanitary officers should be asked their opinion of the danger of pollution from the fourth source, namely, the Najafgarh drainage cut.

(*h*) Allowance for loss by evaporation, etc.

Allowances have been made for loss of water by evaporation and other sources, it may be considered unnecessary to allow such large quantities for these losses, but some provision should be made for loss, especially if it is decided to adopt continuous pumping through the whole 24 hours. If pumping is confined to 16 hours per day the allowance for loss may be ignored as it would always be possible to make up any quantity lost by evaporation or wastage, by pumping for longer hours with the unfiltered water engines, but before the allowance for evaporation and loss is reduced, the next paragraph dealing with increase of population should be considered.

(*i*) Provision for increase of population.

In this project no provision has been made for increase of population in the future, as it is assumed that it will be several years before the inhabitants in the indian city extension will amount to 50,000.

The population will however undoubtedly increase and provision will need to be made for this increase.

During the first few years this expansion could be dealt with by increasing the duration of daily pumping, and the only additional works which would be required would be an increase in the area of the filter beds, and possibly an additional spare engine and pump at each pumping station, until the daily duration of pumping amounted to 24 hours a day when additional plant would be required.

Additional plant would be required at the unfiltered water pumping station earlier, if no allowance for loss by evaporation and wastage is made.

During the past 40 years the population of Delhi has increased by an average of 9½% per decade, and during the last decade the rate of increase was nearly

$10\frac{1}{2}$ %. It may be assumed that the rate of increase will be maintained or increase after the advent of the Government of India, and, for safety, I propose to take the rate of increase as $12\frac{1}{2}$ %.

Assuming that the water consumption increases at the same rate as the population the following amounts will be required :—

present supply	2,000,000	gallons	per	day.
after 10 years	2,250,000	"	"	"
after 20 years	2,531,250	"	"	"
after 30 years	2,847,656	"	"	"

By increasing the hours of pumping up to a maximum of 24 hours per day the engines proposed in the scheme can deliver a supply of 3,000,000 gallons per day, and therefore the provisions proposed above should be ample to deal with all increase of population during the next 30 years, if the pumping hours are increased.

(*j*) Settling tanks.

It has been shown above that there are two alternative types of settling tanks, either of which might be adopted for the water supply, and both of which have points in their favour under certain circumstances.

If the continuous type of tank is adopted, the capacity of the tanks would be reduced, and, consequently, the loss by evaporation would be less, on the other hand it may be considered advisable to give the water a longer period of absolute rest, instead of about half the length of time of practically absolute rest.

The length of time given in text books for water to take in passing through continuous tanks is given as 15 to 20 hours as compared with the 32 hours absolute rest allowed in this project.

(*k*) Filter beds.

Three alternative methods of providing for filtration have been proposed for consideration in the report above :—(1), slow sand filtration, (2) rapid sand filtration, with the aid of precipitants by the Jewell, or other, system of filtration, (3), rough filtration, by the Puech Chabal, or other system followed by slow sand filtration, the rate in the sand filters being allowed at a higher rate than in the first case.

The rate for filtration allowed in the project for slow sand filtration is 30 gallons per square foot per day, it would however be different if the other types were adopted.

(*l*) Engines and pumping plant.

In the report now put up I have assumed that the pumping plant will be a steam one, but the alternatives of generating the power for driving the pumps either by gas, oil, electricity or water should also be considered, the last named may probably be ignored in this case, as it is improbable that a reliable source of water power can be obtained within a reasonable distance of Delhi, but the other four sources of power should all be considered ; in the case of electricity the power would be obtained from the power station for the new capital and it might be found that the electrical plant could be run more economically if it had a constant load to rely on, and that the charges per unit of power would compare favourably with the cost of power from any other source.

In the report I have suggested that a plunger pump should be adopted, but the other different types of pumps and pumping engines should be considered.

For the unfiltered water plant a Humphrey pump, or a centrifugal, might give better results than a plunger pump.

I understand that the Humphrey pump as at present constructed is not applicable to lifts greater than 35 or 40 feet, and, therefore, this type of pump cannot be adopted for the filtered water engines, which will be pumping against a head of over 300 feet.

The duration of daily pumping should also be considered, as it is possible that it may be more economical to provide for a 24 hour pumping day, and decrease the cost of the engines and pumps and rising main than to work for only

16 hours with the smaller engine house staff, working in 2 shifts only, instead of the 3 shifts required for the 24 hour day.

(m) Rising main.

If the 24 hour day is adopted the diameter and cost of the rising main will be reduced; the cost would also probably be reduced if a steel main was provided instead of cast iron; I have adopted cast iron as the life of these pipes is very much longer than that of steel pipes, which may perish in a very few years through the action of corrosive salts in the water and soil surrounding them. The length of the rising main is about $6\frac{3}{4}$ miles, it may therefore be considered advisable to lay this main in duplicate in spite of the extra cost entailed, the risk of the failure of the supply, on account of a burst pipe on the main, would then be reduced.

In the project it is proposed to draw the water supply for the new capital from the rising main *en route* from the pumping station to the service reservoir.

A saving is effected by this means as it is not necessary to lay a distribution pipe along the line of the rising main, but it may be considered better for the rising main to run direct to the service reservoir, and for the distribution to be entirely separate, the engines, in the latter arrangement, would be working against an absolutely constant head, and would consequently be designed to work as economically as possible for this duty.

The risk of the whole city being entirely cut off from water, owing to a burst on certain sections of the main, would also be avoided.

(n) Service reservoir.

The site proposed for the new capital and cantonment reservoir is the highest point of the Ridge behind Talkathora; this site will admit of water being supplied by gravity to the cantonments, and it will, also act as a balancing reservoir for the supply to the new capital.

It may however be considered better to have the service reservoir at a lower level, and thus reduce the length of the rising main and make better use of the distribution pipes as in the present distribution scheme a large number of pipes of the minimum size provided are being used for less than their full capacity.

If the site of the service reservoir is altered it may be found necessary to put in a small installation for raising the supply for cantonments to a sufficiently high elevation to admit of this supply being delivered by gravity to the cantonments.

An alternative which would dispense with the necessity of a service reservoir at all would be to pump direct into the distribution mains, but in this case the risk of break down would be increased, there would be no reserve in case of break down, the size of the rising main and of the pumps would have to be sufficient to deliver double the average daily supply, and the size of the clear water reservoirs at the filtering station would have to be increased.

I have allowed for a service reservoir of sufficient capacity to hold one day's supply in order to allow for some stand by in case of slight break down at the pumping station, or on the 18″ and the first section of the 15″ rising main; it may however be considered advisable to provide for a two or three days supply, or that sufficient provision would be one half a day's storage.

(o) Distribution system.

I propose to provide a complete system of valves on the distribution, so arranged that any small districts can be cut off for repairs without interfering with the supply to the greater part of the site: I also propose to provide meters, on the district meter system, so that any section can be tested for leakage; it may however be considered that this is an unnecessary expense, and that the value of the water likely to be lost by leakage and household waste is not sufficient at present to warrant the outlay on a complete system of district meters, and that for present purposes it will be sufficient, if valves are provided only sufficient to divide the site up into large districts, so that in case of accident a large section would be cut out for repairs instead of only one or two streets.

(*p*) Combined domestic and irrigation supply.

In the event of the combined scheme for domestic and irrigation water supply proving practicable as far as cost is concerned the quantity of water to be allowed per acre of area will need consideration. In the present irrigation project the quantity allowed for irrigation is approximately 1,000,000 gallons per square mile per day.

17. Summary of points referred for orders—

(*a*) Population.

1. New Capital.

2. Cantonments.

3. Indian city extension.

(*b*) Quantity of supply per head.

1. Europeans.

2. Indians.

3. Special purposes.

4. Cantonments.

(*c*) Irrigation of ridge.

1. Whether supply is to be from the domestic or the irrigation supply.

2. Area afforested.

3. Quantity required per acre per day.

(*d*) Cantonment irrigation.

1. Whether this supply, if required, is to be provided from the irrigation or domestic water supply.

2. Quantity required.

(*e*.) Existing water works.

1. Whether these works and the supply delivered by them should be kept for the present city and civil lines supply, or whether they may be extended to supply to certain of the low lying areas in the new capital and city extension.

(*f*) Proportional charges.

1. Whether the capital cost and maintenance charges are to be proportioned out to the three share holders, or the new capital is to deliver water at a fixed charge per 1,000 gallons to the other sites.

(*g*) Site of intake works.

(*h*) Allowances to be made for loss by evaporation and wastage from settling tanks and filters.

(*j*) Provision for increase of population.

(*i*) Settling tanks.

1. Type of tank.

2. Length of time allowed for absolute or practically absolute rest.

3. Velocity of water if continuous tanks are adopted.

(*k*) Filter beds.

1. Slow sand filters or rapid sand filters or a combination of the two.

2. Rate of filtration allowable in the three different cases above.

(*l*) Engines and pumps.

1. Source of power.

2. Type of engine and pump, etc., for unfiltered water supply.

3. Type of engines and pumps etc., for filtered water supply.

4. Duration of daily pumping.

(*m*) Rising main.

1. Material from which it should be made.

2. Single or double line

3. Whether it should be used as a distributing main or not.

(*n*) Service reservoir.

1. Site.

2. Capacity.

(*o*) Distribution system.

1. Valves on system.

2 Meters.

(*p*) Combined scheme.

18. *Programme of work.*—It is assumed that the detailed plans and estimate will be prepared and sent to the Secretary of State for sanction by the beginning of April 1913, and that he will accept tenders for the manufacture of the pumping machinery and for certain of the pipes etc., by the beginning of June.

It is also assumed that the successful tenderer for the engines will require 12 months for manufacture and delivery, and that therefore the engines cannot be delivered in this country until the middle of the year 1914-15.

During the first year or two of construction one engine would be sufficient to provide the whole supply required, it will however be advisable to have two sets in case of accident. It will also probably be thought best to have the three sets of engines at each station of the same design, so that the manufacturer who makes the first set will make the three sets, his tender is not likely to be reduced if he is given a long time for manufacture, as the probability is that he will cast and machine all the parts for the three engines at the same time. I am assuming that the third engine will be supplied during the 2nd year after acceptance of tender.

I am therefore basing my programme of work on the above assumptions:—namely that a supply of water will be given at the end of the year 1914-15.

In the building programme provision is made for an expenditure of $\frac{1}{4}$ of the total during 1913-14 and $\frac{1}{2}$ of the total during 1915-16, therefore it may be assumed that a supply will be required for residences as soon as the supply can be given ; temporary arrangements being made for the supply for building until this time.

The contractors for supplying the pipes will require from 4 to 6 months to manufacture and deliver them, and therefore some of the pipes could be supplied during 1913-14.

In order to economise the cost of the temporary water supply, I propose to provide a certain proportion of the distribution pipes a year before the engines are to be supplied, these pipes will be put down temporarily as required for building operations, and will be subsequently taken up and relaid when the final distribution is taken in hand.

Buildings for housing the engines etc., will be built during 1913-14 so as to be ready when the engines are delivered, and only a small amount of work will be kept over to be carried out after the engines are erected.

During the year 1912-13 the only work likely to be done on this scheme will be the preparation of the detailed plans and estimates and it may be assumed that practically all the preliminary work will be finished before the end of this year. I am however leaving a small sum in case of further details or alterations to the scheme being required and to cover the expenditure on contracts etc., and on any investigations into the river training works.

During 1913-14 the greater part of the work on the engine houses, intake and piping at the unfiltered water station, and the engine houses at the filtered water station will be completed, the greater part of the earth work on the settling tanks, filters and clean water reservoirs will be done, in order to give the banks of the settling tanks time to settle before being used, materials for construction of these tanks etc., will also be collected, the sand-washer will be built, so as to be ready for washing the filter bed sand, when it is collected, the tramway will be bought for use during construction, roads will be made for construction purposes and a proportion of the distribution piping will be obtained and temporarily laid. I propose to provide ⅓rd of this piping during this year, and also to put in the telephone installation for construction purposes.

During 1914-15 two sets of engines at each station will be erected and tested, a small percentage of their cost being held back during the maintenance period, the rising mains laid, two of the settling tanks built and one half the filter beds and clean water reservoirs built, a further instalment of ⅓rd of the distribution piping will be bought, and ½ of this piping laid to such residences etc., as are finished or nearly so, one of the service reservoirs will be built and the river training further investigated.

During 1915-16 the river training works will be built, the third sets of engines will be erected, the third settling tank and a further instalment of filter beds built, the second clear water and service reservoirs will be completed, and the remaining distribution piping bought and another ¼ of it finally laid.

During 1916-17 the works will be finished the remaining distribution piping being finally laid, the engine houses completed, roads put into repair, the fencing round the site erected, and the telephone permanently fixed.

Provision has been made for the completion of the works by the beginning of the year 1917-18, as it is assumed that water will be required in all parts of the new capital either for residences already occupied or for those being built.

In the project estimate the cost of engines and pumps and all buildings has been taken at an inclusive rate, it is now necessary to estimate separately for the cost of the buildings and of the engines as the latter will be built in England.

In the estimate for the Benares works the cost of buildings works out at Rs. 205 per H. P. for the unfiltered water plant and at Rs. 176 per H. P. for the filtered water, the H. P. being 282 and 456 respectively.

In the Bareilly waterworks estimate for buildings for a 27 H. P. plant the cost works out at Rs. 228 per H. P., and in the Ambala works for engines of 48 H. P. at Rs. 263 per H. P.

I propose to adopt Rs. 300 per H. P. for the cost of engine and boiler house, staff quarters etc., for the unfiltered water plant of 64½ H. P. and Rs. 250 per H. P. for those for the filtered water plant of 339 H. P. The rates taken in the estimate for engines and boilers etc., and all buildings were obtained from the Honourable Mr. Goument, Chief Engineer to the United Provinces Government and amounted to Rs. 1,200 per H. P. for the unfiltered water plant, and Rs. 1,000 per H. P. for the larger filtered water plant. Making the above deductions off these rates, to cover the cost of buildings, the estimated cost of the engines etc., works out at Rs. 900 and Rs. 750 per H. P. respectively; this latter figure agrees with the price tendered by Messrs. Turner Hoare and Company for the Lahore waterworks engines, for engines of 126 H. P, ; the rate for the unfiltered water plant is larger than their tender but this is for a small plant, and the rate per H. P. would probably be greater.

In the project estimate the rate for cast iron pipes was taken as Rs. 8 per cwt ; this must now be subdivided into cost of pipes and cost of laying.

I am allowing for lead joints to all pipes, and at the following weights of lead per joint :—

36″	diameter	pipe	80	lbs.	of	lead	...	...	...
21″	"	say	40	"	"	"	...	...	
18″	"	"	$32\frac{1}{2}$	"	"	"	...	...	...
15″	"	"	26	"	"	"	...	...	...
8″	"	"	$10\frac{1}{2}$	"	"	"	...	...	...
7″	"	"	$8\frac{3}{4}$	"	"	"	...	...	...
6″	"	"	7	"	"	"	...	...	...
5″	"	"	$5\frac{1}{2}$	"	"	"	...	...	...
4″	"	"	4	"	"	"	...	...	...
3″	"	"	$2\frac{3}{4}$	"	"	"	...	...	...

The lengths of each pipe will be, from 36″ to 12″ diameter 12 feet, below 12 diameter 9 feet ; and taking the cost of lead at Rs. 20 per cwt. and making an allowance for yarn in the joints the total cost of jointing materials works out at Rs. 69,560. say Rs. 70,000.

The total weight of pipes is 115,790 cwts. therefore the cost of jointing materials works out an average rate of nearly annas 8 per cwt. of pipe.

This however assumes that all the pipes are of the full length of 12 and 9 feet respectively ; there will however be a large proportion of special pipes, bends, etc., of shorter length. I therefore propose to assume the cost of materials per joint will cost an average rate of annas 12 per cwt. of pipe.

I am taking the cost of pipes on board ship in port of landing as Rs. 5 per cwt., jointing materials annas 12 per cwt. of pipe weight, landing charges and railway freight, say, Rs. 1-4 per cwt., local carting, laying and jointing annas 12 per cwt., contingencies annas 4 per cwt. Total Rs. 8 per cwt. or say Rs. 6 for english charges and Rs. 2 for indian charges.

The above rates are high but provision must be made for rock cutting, of which there may be a considerable quantity in certain parts of the work.

For the tramway, telephone installation, and fencing I am dividing the rates up in the proportion of 90 per cent materials and 10 per cent labour as a rough assumption for the cost.

The foregoing programme of work has been made out on the assumption that all the engines, pumps, boilers, pipes, etc., will be purchased in England through the Secretary of State, and a longer time has been allowed on this account, as it is possible that certain alterations may be made by him in the designs, etc. If powers be given to the engineers on the spot, connected with this work to deal direct with the manufacturers it would probably be possible to expedite the work by 6 or 9 months, and in consequence to deliver water to certain parts of the site, and the buildings being erected thereon, at a correspondingly earlier date.

I believe this was done in the case of the recent Durbar and that certain engines, pipes, etc., were delivered, erected, and at work within six months of the order being given.

A schedule of the rates used in the estimate will be found in appendix E.

Programme of annual expenditure on the domestic water supply for the New Capital.

Description of work.	DOMESTIC WATER SUPPLY FOR NEW CAPITAL. Estimated cost.			PROGRAMME OF WORK. Programme of expenditure.						Total.
	Estimated cost.	In India.	In England.	1912-13.	1913-14.	1914-15	1915-16.	1916-17.	1917-18.	
Unfiltered Water Supply.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
River training works	50,000	50,000	...	...	...	...	50,000	...	...	50,000
Intake	20,000	20,000	...	...	18,000	2,000	...	...	...	20,000
Supply pipe	4,240	1,060	3,180	...	4,240	...	...	...	...	4,740
Suction well	4,000	4,000	...	...	3,600	400	...	...	...	4,000
Engines, etc.	38,700	9,675	29,025	...	8,675	18,883	10,408	734	...	38,700
Rising main	11,200	2,800	8,400	...	...	11,200	...	...	...	11,200
Valves, etc.	5,000	1,250	3,750	...	...	5,000	...	...	..	5,000
Purification Plant.										
Settling tanks	43,000	43,000	...	...	16,425	16,125	10,750	...	...	43,000
Filter beds	40,000	40,000	...	...	20,000	15,000	3,750	1,250	...	40,000
Clear water reservoir	17,500	17,500	...	...	4,375	6,563	6,562	...	...	17,500
Pipes, valves, etc.	25,000	6,250	18,750	...	5,000	15,000	5,000	...	...	25,000
Sandwasher	1,750	1,750	...	...	1,750	...	...	...	...	1,750
Tramway	5,000	500	4,500	...	5,000	...	...	...	...	5,000
Filtered water engines, etc.	1,69,500	42,375	1,27,125	...	38,375	82,513	45,494	3,118	...	1,69,500
Rising Main.										
18" main	1,09,760	27,440	82,320	...	...	1,09,760	...	...	...	1,09,760
15" main	1,83,424	45,856	1,37,568	...	...	1,83,424	...	...	...	1,83,424
Valves, etc.	7,500	1,875	5,625	..	...	7,500	...	...	...	7,500
SERVICE RESERVOIR	50,000	50,000	...	...	12,500	25,000	12,000	...	...	50,000
DISTRIBUTION	5,44,640	1,36,660	4,09,980	...	1,36,660	2,04,990	1,70,825	34,165	...	5,46,640
General.										
Telephone line	3,030	303	2,727	...	2,880	...	...	150	...	3,030
Telephone instruments	4,050	...	4,050	...	4,050	"	...	...	...	4,050
Roads	5,000	5,000	...	...	3,750	250	250	750	...	5,000
Fencing site	1,750	175	1,575	..	...	...	..	1,750	...	1,750
Preliminary expenses	10,000	10,000	...	8,334	1,110	556	...	...	...	10,000
Total ...	13,56,044	5,17,469	8,38,575	8,334	2,86,090	7,04,164	3,15,539	41,917	...	13,56,044

Programme of annual expenditure on the domestic water supply for Cantonments.

Description of work.	DOMESTIC WATER SUPPLY FOR CANTONMENTS. Estimated cost. Estimated cost.	In India.	In England.	PROGRAMME OF WORK. Programme of expenditure. 1912-13.	1913-14.	1914-15.	1915-16.	1916-17.	1917-18.	Total.
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
UNFILTERED WATER SUPPLY.										
River training works	12,500	12,500	...	...	...	...	12,500	...	...	12,500
Intake	5,000	5,000	...	...	4,500	500	...	...	...	5,000
Supply pipe	1,060	265	795	...	1,060	...	...	...	...	1,060
Suction well	1,000	1,000	...	...	900	100	...	...	...	1,000
Engines, etc.	9,675	2,419	7,256	...	2,169	4,721	2,602	183	...	9,675
Rising main	2,800	700	2,100	...	...	2,800	...	...	...	2,800
Valves, etc.	1,250	313	937	...	...	1,250	...	...	...	1,250
PURIFICATION PLANT.										
Settling tanks	10,750	10,750	...	...	4,031	4,031	2,688	...	...	10,750
Filter beds	10,000	10,000	...	...	5,000	3,750	938	312	...	10,000
Clear water reservoir	4,375	4,375	...	...	1,094	1,641	1,640	...	...	4,375
Pipes, valves, etc.	6,250	1,563	4,687	...	1,250	3,750	1,250	...	...	6,250
Sandwasher	437	437	...	...	437	...	...	...	...	437
Tramway	1,250	125	1,125	...	1,250	...	...	...	...	1,250
Filtered water engines, etc.	42,375	10,594	31,781	...	9,594	20,628	11,374	779	...	42,375
RISING MAIN.										
18″ main	27,440	6,860	20,580	...	...	27,440	...	...	...	27,440
15″ main	45,856	11,464	34,392	...	...	45,856	...	..	...	45,856
Valves, etc.	1,875	469	1,406	...	...	1,875	...	...	...	1,875
SERVICE RESERVOIR	12,500	12,500	...	...	3,125	6,250	3,125	...	...	12,500
GENERAL.										
Telephone line	758	76	682	...	720	...	...	38	...	758
Telephone instruments	1,012	...	1,012	...	1,012	..	...	...	...	1,012
Roads	1,250	1,250	...	...	938	63	62	187	...	1,250
Fencing	438	44	394	...	...	...	...	438	...	438
Preliminary expenses	1,000	1,000	...	833	112	55	...	...	...	1,000
Total ...	2,00,851	93,704	1,07,147	833	37,192	1,24,710	36,179	1,937	...	2,00,851

Programme of annual expenditure on domestic water supply for the Indian city extension.

Description of work.	DOMESTIC WATER SUPPLY FOR INDIAN CITY EXTENSION. — ESTIMATED COST.			PROGRAMME OF WORK. — PROGRAMME OF EXPENDITURE.						Total.
	Estimated cost.	In India.	In England.	1912-13.	1913-14.	1914-15.	1915-16.	1916-17.	1917-18.	
UNFILTERED WATER SUPPLY.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
River training works	37,500	37,500	...	...	...	...	37,500	...	...	37,500
Intake	15,000	15,000	...	...	13,500	1,500	...	...	...	15,000
Supply pipe	3,180	795	2,385	...	3,180	...	...	...	...	3,180
Suction well	3,000	3,000	...	...	2,700	300	...	...	...	3,000
Engines, etc.	29,025	7,257	21,768	...	6,507	14,163	7,806	549	...	29,025
Rising main	8,400	2,100	6,300	...	...	8,400	...	...	...	8,400
Valves, etc.	3,750	939	2,811	...	...	3,750	...	...	...	3,750
PURIFICATION PLANT.										
Settling tanks	32,250	32,250	...	...	12,093	12,093	8,064	...	...	32,250
Filter beds	30,000	30,000	...	...	15,000	11,250	2,814	936	...	30,000
Clear water reservoir	13,125	13,125	...	...	3,282	4,922	4,921	...	...	13,125
Pipes, valves, etc.	18,750	4,689	14,061	...	3,750	11,250	3,750	...	...	18,750
Sandwasher	1,313	1,313	...	...	1,313	...	...	...	...	1,313
Tramway	3,750	375	3,375	...	3,750	...	...	...	...	3,750
Filtered water engines, etc.	1,27,125	31,782	95,343	...	28,782	61,884	34,122	2,337	...	1,27,125
RISING MAIN.										
18" main	82,320	20,580	61,740	...	...	82,320	...	...	...	82,320
Valves, etc.	5,625	1,407	4,218	...	...	5,625	...	...	...	5,625
GENERAL.										
Telephone line	2,272	227	2,045	...	2,160	...	...	112	...	2,272
Telephone instruments	3,038	...	3,038	...	3,038	...	...	...	...	3,038
Roads	3,750	3,750	...	...	2,812	187	188	563	...	3,750
Fencing	1,312	131	1,181	...	...	...	...	1,312	...	1,312
Preliminary expenses	1,000	1,000	...	833	112	55	...	...	...	1,000
GRAND TOTAL ...	4,25,485	2,07,220	2,18,265	833	1,01,979	2,17,699	99,165	5,809	...	4,25,485

Abstract of programmes of annual expenditure.

Description of work.	DOMESTIC WATER SUPPLY. Estimated cost.			PROGRAMME OF WORK. Programme of expenditure.						Total.
	Estimated cost.	In India.	In England	1912-13.	1913-14.	1914-15.	1915-16.	1916-17.	1917-18.	
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
New capital	13,56,044	5,17,469	8,38,575	8,334	2,86,090	7,04,164	3,15,539	41,917	...	13,56,044
Cantonment	2,00,851	93,704	1,07,147	833	37,192	1,24,710	36,179	1,937	...	2,00,851
Indian city extension	4,25,485	2,07,220	2,18,265	833	1,01,979	2,17,699	99,165	5,809	...	4,25,485
Total ...	19,82,380	8,18,393	11,63,987	10,000	4,25,261	10,46,573	4,50,883	49,663	...	19,82,380
	...	...	...	10,000	4½ lakhs.	10½ lakhs.	4½ lakhs.	½ lakh	...	...
	Rs. 19,82,380			Rs. 19,82,380						

This programme is for the full supply to the new capital and for that to the cantonments and indian city extensions as far as they are included in the scheme for the new capital.

Of the sums shown overleaf as being the annual estimated expenditure on the works, the allocation to work carried out in India and in England is as follows:—

	For work in India.				
	1912-13.	1913-14.	1914-15.	1915-16.	1916-17.
	Rs.	Rs.	Rs.	Rs.	Rs.
New Capital ...	8,334	1,31,223	2,19,695	1,20,477	37,740
Cantonments ...	833	32,640	37,758	21,580	893
Indian city extension ...	833	88,323	60,019	55,368	2,677
Total ...	10,000	2,52,186	3,17,472	1,97,425	41,310
			Rs. 8,18,393		

	For work in England.				
	1912-13.	1913-14.	1914-15.	1915-16.	1916-17.
	Rs.	Rs.	Rs.	Rs.	Rs.
New capital ...	...	1,54,867	4,84,469	1,95,062	4,177
Cantonments ...	...	4,552	86,952	14,599	1,044
Indian city extension ...	...	13,656	1,57,680	43,797	3,132
Total ...	...	1,73,075	7,29,101	2,53,458	8,353
			Rs. 11,63,987		

Estimate of cost of domestic water supply.

Description.	Quantity.	Rate.	Amount.	Total.
		Rs.	Rs.	Rs.
1. UNFILTERED WATER SUPPLY—				
(a) River training and protective works...	Lump sum.	...	1,00,000	...
(b) Intake	Lump sum.	...	40,000	...
(c) Supply pipe 36″ dia.	1,060 cwts.	8 cwt.	8,480	...
(d) Suction well	Lump sum.	...	8,000	...
(e) Engines and pumps etc., including all buildings.	64½ H. T.	1,200 H. P.	77,400	...
(f) Rising main 21″ dia.	2,800 cwts.	8 cwt.	22,400	...
(g) Valves, meters etc.	Lump sum.	...	10,000	2,66,280
2. PURIFICATION PLANT—				
(a) Settling tanks	8,600,000 gallons.	10 °%	86,000	...
(b) Filter beds	80,000 s. ft.	1 s. ft.	80,000	...
(c) Clear water reservoirs	700,000 gallons.	50 °%	35,000	...
(d) Pipes, valves, meters, drains etc. ...	Lump sum.	...	50,000	...
(e) Sandwasher	Lump sum.	...	3,500	...
(f) Tramway	Lump sum.	...	10,000	2,64,500
3. FILTERED WATER SUPPLY—				
(a) Engines and pumps etc., including all buildings.	339 H. P.	1,000 H. P.	3,39,000	3,39,000
4. RISING MAIN—				
(a) 18″ diameter	27,440 cwts.	8 cwt.	2,19,520	...
(b) 15″ „	28,660 cwts.	8 cwt.	2,29,280	...
(c) Valves, meters etc.	Lump sum.	...	15,000	4,63,800
5. Service reservoir	1,250,000 gallons.	50 °%	62,500	62,500
6. DISTRIBUTING SYSTEM—				
(a) Pipes	55,830 gallons.	8 cwt.	4,46,640	...
(b) Valves, meters etc.	Lump sum.	...	1,00,000	5,46,640
7. GENERAL ITEMS—				
(a) Telephone lines	10 miles	606 mile	6,060	...
(b) Instruments	No. 6.	1,350 each.	8,100	...
(c) Roads at site	Lump sum.	...	10,000	...
(d) Fencing site	Lump sum.	...	3,500	27,660
8. Preliminary expenses	Lump sum.	...	12,000	12,000
Total ...	...	...	Rs.	19,82,380

DOMESTIC WATER SUPPLY.

Proportional charges to new capital, cantonments and indian city extensions.

Particulars.			Total amount.	PROPORTIONAL COSTS.		
				New capital.	Cantonments.	Indian city extensions.
			Rs.	Rs.	Rs.	Rs.
1. Unfiltered water supply	...	...	2,66,280	1,33,140	33,285	99,855
2. Purification Plant	...	...	2,64,500	1,32,250	35,062	99,188
3. Filtered water supply	...	...	3,39,000	1,69,500	42,375	1,27,125
4. Rising main 18"	...	...	2,19,520	1,09,760	27,440	82,320
Ditto 15"	...	...	2,29,280	1,83,424	45,856	...
Valves, meters etc.	...	...	15,000	7,500	1,875	5,625
5. Service Reservoir	...	...	62,500	50,000	12,500	...
6. Distributing system	...	...	5,46,640	5,46,640	...	...
7. General items	...	...	27,660	13,830	3,458	10,372
8. Preliminary expenses	...	...	12,000	10,000	1,000	1,000
Total Rs.		...	19,82,380	13,56,044	2,00,851	4,25,485

APPENDIX A.

Areas provided in the lay out.

		Acres.
	Government House and Viceregal staff quarters	311
	Commander-in-Chief's residence and staff quarters	63½
6	Members of Council	36
3	Members of Railway Board	15
1	Bishop	5
35	Secretaries	175
40	Deputy Secretaries	171
133	Under Secretaries	398
107	Registrars etc	149
108	First class european clerks	108
451	Other european clerks	246
620	Indian clerks	360
1782	Indian clerks under Rs 100	178
1943	Peons	39
2	European gardeners	In parks.
1	Bishops chaplain	In cathedral park.
16	Administrative and municipal officers	48
	Extra sites for official bungalows	35
	Club and tennis grounds	67½
	Theatre and concert rooms	2
	Tennis grounds for officers and staff	15
	European and indian club	5
	Race course	In Bela or across the Ridge.
	Golf course	334
	Polo grounds	46
75	Indian chiefs villa residences	498
400	Indian raises	390
	Hotels	38
	First class european and indian shops	18
	First class shopkeepers' residences	146
	Markets	10
	Indian bazaars, european and indian settlers	135
	Town hall and commissioner's office	2
	Medical school and civil hospital	30
	Veterinary hospital	6
	Post and telegraph office	2
	Central police and fire Station	2
	Sub-police, fire, post and telegraph station	3
	Vegetable and meat markets	10
	Dairy farm and buildings	30
	Quarters for municipal cattle	10
	Quarters for municipal menials	15
	Conservancy and municipal depôt	12
	Cemeteries	96
	Slaughter house	In isolation zone.
	Municipal Minor officials	5
	University, 2 colleges and school	275
	Orphanages and charitable institutions	25
	Dispensary	3
	Schools	32
	Doubtful area for officials residences and 3 ministers	110
	R. C. Church, Presbyterian and Weslyan Church	9
	Stamp, Stationery and Press office, Press	Across the Ridge.
	Oriental research institute	70
	Secretariat block parks	129
	Secretariat extensions parks including cathedral and museum site	169
	Place in front of secretariats and Government House	108
	Safdar Jang Park	115
	Lodi Tomb Park	144
	Jantar Mantar Park	21
	Delhi City Park	407

APPENDIX B.

Revised estimated quantity of water supply.

Description.	Number of houses.	Europeans. Number per house.	Europeans. Total.	Indians. Number per house.	Indians. Total.
Commander-in-Chief ...	1	34	34	200	200
Members of Council and Bishop.	10	4	40	50	500
Secretaries, Deputy Secretaries, Generals and Colonels.	79	4	316	30	2,370
Under Secretaries, Majors and Captains.	103	4	412	25	2,575
Uncertain officers ...	40	4	160	25	1,000
Registrars	15	4	60	10	150
Superintendents ...	74	4	296	10	740
Clerks, european and indian.	2,770	1	2,770	2	5,540
Peons	2,000	...	...	3	6,000
European gardeners ...	2	3	6	5	10
Bishop's chaplain ...	1	3	3	25	25
Commissioners ...	1	4	4	30	30
Assistant Commissioners, Engineers, Police etc.	7	3	21	25	175
Police Inspectors ...	2	2	4	5	10
Head clerks ...	5	...	...	5	25
Clerks, draftsmen etc. ...	50	...	...	4	200
Ruling chiefs ...	...	...	...	1,200	1,200
Raises	...	...	...	1,000	1,000
Shop keepers, european ...	50	4	200	12	600
Shop keepers, indian ...	50	...	...	4	200
Hotels (6 in number) ...	...	...	350	...	1,000
Residential club ...	1	50	50	150	150
Bazars, european and indian settlers menials, police etc.	...	...	...	...	13,000
Hospital	...	50	50	150	150
Schools and colleges ...	...	...	...	400	400
Press taken in city extension supply.	...	...	...	...	...
Total ...	...	...	4,776	...	37,250
Say ...	...	...	5,000	...	40,000

Water supply required—

5,000 Europeans at 30 gallons	...	...=	150,000 gallons per day.
40,000 Indians at 15 gallons	...	...=	600,000 gallons per day.
	Total	...	750,000 " " "

Government House supply.

In file 4-5-D, the water consumption of Government House, Simla for May and June is given. This amounts to 20,500 gallons per day, but this consumption is hardly a fair criterion for the Delhi calculations as every supply within the Viceregal grounds is carefully metered on account of the heavy charges for water.

Allow 25,000 gallons per day for the Delhi supply.

Special purposes for which no population can be given.

First class shops, (100 at 25 gallons per day)	25,000	gallons per day.
Club	1,000	ditto.
Theatre	500	ditto.
Tennis courts	500	ditto.
Race course	1,000	ditto.
Golf course	500	ditto.
Polo grounds	500	ditto.
Town hall	1,000	ditto.
Veterinary hospital	1,000	ditto.
Markets	2,500	ditto.
Dairy	2,500	ditto.
Municipal cattle	2,500	ditto.
Secretariats	2,500	ditto.
Total ...	41,000	ditto.
say ...	50,000	ditto.

Total supply required for New Capital.

Europeans 5,000 at 30 gallons per head per day	150,000	ditto.
Indians 40,000 at 15 " " "	600,000	ditto.
Government House	25,000	ditto.
Shops, clubs, etc., etc.	50,000	ditto.
Total ...	825,000	ditto.
Add 10 per cent contingences ...	82,500	ditto.
Grand total ...	907,500	

say 1,000,000 gallons per day.

Cantonment supply.

As per Army Department notes 240,000 gallons per day.

say 250,000 gallons per day.

City extensions.

Including 12,000 Press settlement.

Area 1½ square miles say, 1,000 acres.

at a density of say 50 per acre 50,000 at 15 gallons per head per day= ... 750,000 gallons per day.

Total supply required per day.

New Capital	1,000,000	gallons.
Cantonments	250,000	"
City extensions	750,000	"
Total ...	2,000,000	gallons per day.

APPENDIX C.

Note on the gallons per day per acre of the different classes of suburb into which the new Capital area can be divided.

In the figures I have allowed for water supply, the numbers do not agree altogether with those in the list of areas which is presumably a more recent list than the one on which I prepared my estimate of consumption.

Class of Suburb.	Inhabited by	Gallons per day.		Gallons per acre per day.	
		As calculated.	With 27 per cent added.	As calculated.	With 27 per cent added.
Class I ...	Officers bungalows ...	153,435	194,862	154	196
Class II ...	Government House ...	25,000	31,750	80	102
	Commander-in-Chief ...	4,020	5,105	63	80
Class III ...	Indian chiefs	33,000	41,910	37	47
Class IV ...	Superintendents	24,030	30,518	253	321
Class V ...	European clerks	83,100	105,537	321	408
Class VI ...	Indian clerks	86,475	109,823	161	204
Class VII ...	Peons	90,000	114,300	2,308	2,931
Class VIII ...	Hotels	25,500	32,385	671	852
Class IX ...	Bazaars	195,000	247,650	1,444	1,834
Class X ...	Markets	2,500	3,178	250	318
Class XI ...	1st class shops	2,500	3,175	139	175
Class XII ...	Shopkeepers	18,000	22,860	123	156
	Clubs	7,750	9,842	...	...
	Hospital	4,750	6,032	...	...
	Schools	6,000	7,620	...	...
Special ...	Town Hall	1,000	1,270	...	...
	Dairy	2,500	3,175	...	...
	Municipal cattle, etc. ...	2,500	3,175	...	...
	Secretariats	25,000	31,750	...	...
	Total ...	792,060	1,005,914	...	...

Abstract of water supply estimate.

Government House	...	25,000	gallons per day.
Europeans 4,776 say 5,000 at 30 gallons per head per day	...	150,000	ditto.
Natives 37,250 say 40,000 at 15 gallons per head per day	...	600,000	ditto.
Shops, clubs, etc., etc., 41,000 gallons per day, say	...	50,000	ditto.
Total	...	825,000	ditto.
Contingencies say 10 per cent ...	...	82,500	ditto.
Grand total	...	907,500	ditto.

say 1,000,000 gallons per day.

1. Officers' bungalows,—Number 344—Area 997 acres.

Number.	Designation.	Europeans.	Indians.
10	Members of Council etc.	40	500
79	Secretaries, etc.	316	2,370
143	Under Secretaries, etc.	572	3,575
15	Registrars	60	150
74	Superintendents	296	740
2	European gardeners	6	10
1	Bishop's chaplain	3	25
1	Commissioner of Enclave	4	30
7	Assistant Commissioners, etc.	21	175
2	Police Inspectors	4	10
334	Total ...	1,322	7,585

		Gallons.
1,322 Europeans at 30 gallons per day		= 39,660
7,585 Indians at 15 gallons per day		= 1,13,775
Total	...	1,53,435

Officers' bungalows 153,435 gallons per day.

2. Indian Chiefs.—Number 475—

		Gallons.
Ruling chiefs		1,200
Raises		1,000
Total	...	2,200
2,200 Indians at 15 gallons per day		33,000

Indian Chiefs etc., 33,000 gallons per day.

3. Superintendents,—Number 95—

These have already been taken under officers' bungalows above in order to approximate to the number 344.

356 Europeans at 30 gallons per head ... ... 10,680 gallons.
890 Indians at 15 gallons per head 13,350

Total ... 24,030 gallons.

Superintendents, 24,030 gallons per day.

4. European Clerks—
2,770 clerks at 30 gallons per day ... ... 83,100 gallons.

5. Indian Clerks 5,540
Clerks to administrative officers 225
5, 765 at 15 gallons per day ... ... 86,475 gallons.

6. Peons 6,000 at 15 gallons per day ... ... 90,000 gallons.

7. Hotels—
350 Europeans at 30 gallons per day ... ... 10,500 gallons.
1,000 Indians at 15 ditto ... ... 15,000 ditto.

Total ... 25,500 ditto.

8. Bazaars—
13,000 Indians at 15 gallons per day ... ... 1,95,000 gallons.
9 Markets ... ... 2,500 ditto.
10. 1st Class shops ... ... 2,500 ditto.
11. Shop keepers—
200 at 30 gallons per day... 6,000
800 at 15 gallons per day... 12,000

18,000 ditto.

12. Clubs—
50 at 30 gallons per day 1,500
150 at 15 gallons per day 2,250
Clubs 1,000
Theatre 500
Tennis Courts 500
Race Course 1,000
Golf Course 500
Polo Ground 500

7,750 ditto.

13. Hospital—
50 at 30 gallons per day 1,500
150 at 15 gallons per day 2,250
Veterinary hospital 1,000

Total ... 4,750 gallons.

14. Schools and Colleges—
400 at 15 gallons per day ... ... 6,000 gallons.
15. Town Hall ... ... 1,000 ditto.
16. Dairy ... ... 2,500 ditto.
17. Municipal cattle, etc. ... ... 2,500 ditto.
18. Secretariats ... ... 25,000 ditto.
19. Commander-in-Chief—
34 at 30 gallons per day 1,020
200 at 15 gallons per day 3,000

Total ... 4,020 gallons.

20. Government House ... ... 25,000 ditto.

APPENDIX D.

Estimate of pipes required for domestic water supply distribution scheme.

Name of pipe.	Diameter of pipes.					
	3-inch.	4-inch.	5-inch.	6-inch.	7-inch.	8-inch.
	Feet	Feet.	Feet.	Feet.	Feet.	Feet.
18—35	...	...	...	...	1,716	...
19—36	...	...	...	...	1,540	...
20—37	...	...	...	1,606	...	...
38—39	...	...	...	1,342	...	...
40—41	...	...	1,672	...	...	...
40—42	...	1,663	...	...	...	...
42—61	2,244	...	...	...	...	...
42—78	1,100	...	...	...	...	...
18—19	1,760	...	...	...	...	...
19—20	2,640	...	...	...	...	...
19—19	2,200	...	...	...	...	...
9—19	2,200	...	...	...	...	...
20—39	1,760	...	...	...	...	...
20—20	1,760	...	...	...	...	...
20—21	1,980	...	...	...	...	...
39—41	1,760	...	...	...	...	...
39—39	1,760	...	...	...	...	...
39—43	1,650	...	...	...	...	...
41—42	1,760	...	...	...	...	...
41—41	1,760	...	...	...	...	...
41—43	2,112	...	...	...	...	...
34—35	...	...	1,628	...	...	...
56—57	...	...	2,244	...	...	...
75—76	1,100	...	...	...	...	...
76—76	924	...	...	...	...	...
77—77	462	...	...	...	...	...
78—78	858	...	...	...	...	...
9—18	2,332	...	...	...	...	...
34—56	1,254	...	...	...	...	...
33—34	1,496	...	...	...	...	...
55—56	2,244	...	...	...	...	...
56—75	836	...	...	...	...	...
57—58	2,244	...	...	...	...	...
58—7	682	...	...	...	...	...
Carried over ...	42,878	5,535	1,672	2,948	3,256	...

Estimate of pipes required for domestic water supply distribution scheme—contd.

Name of pipe.	Diameter of pipes. 3-inch.	4-inch.	5-inch.	6 inch.	7-inch.	8-inch.
	Feet.	Feet.	Feet.	Feet.	Feet	Feet.
Brought forward ...	42,878	5,535	1,672	2,948	3,256	...
58— 59	2,244	...	...	...	...	...
60— 78	616	...	...	...	...	...
59— 60	2,244	...	...	...	...	...
35— 57	1,320	...	...	...	...	...
36— 58	1,188	...	...	...	...	...
37— 59	1,254	...	...	...	...	...
38— 60	1,112	...	...	...	...	...
40— 61	1,320	...	...	...	...	...
60— 61	2,244	...	...	...	...	...
35— 35	1,650	...	...	...	...	...
35— 36	1,650	...	...	...	...	...
36— 37	1,650	...	...	...	...	...
37— 37	1,672	...	...	...	...	...
37— 38	1,672	...	...	...	...	...
38— 40	1,650	...	...	...	...	...
40— 40	1,650	...	...	...	...	...
17— 18	...	...	...	...	...	1,408
1— 8	...	...	...	...	...	1,342
1— 2	...	...	...	...	...	1,500
2— 2	...	...	...	...	...	1,804
4— 5	...	...	...	...	...	1,100
13— 14	...	...	...	...	...	1,408
17— 34	...	...	1,320	...	...	...
17— 33	...	...	1,364	...	...	...
16— 32	...	...	1,034	...	...	...
16— 31	...	...	968	...	...	...
15— 30	...	...	1,056	...	...	...
15— 29	...	...	968	...	...	...
14— 28	...	...	968	...	...	...
14— 27	...	...	1,112	...	...	...
2— 5	836	...	...	...	...	...
2— 6	836	...	...	...	...	...
2— 7	836	...	...	...	...	...
2— 8	1,056	...	...	...	...	...
Carried over ...	71,578	5,535	10,462	2,948	3,256	8,5[illegible]2

Estimate of pipes required for domestic water supply distribution scheme—contd.

Name of pipe.	Diameter of pipes.					
	3-inch.	4-inch.	5-inch.	6-inch.	7-inch.	8-inch.
	Feet.	Feet.	Feet.	Feet	Feet.	Feet.
Brought forward ...	71,578	5,535	10.462	2,948	3,256	8,562
5—14	1,320	...	...	...	...	...
6—15	1,364	...	...	...	...	...
7—16	1,364	...	...	...	...	...
8—17	1,870	...	...	...	...	...
16—17	1,430	...	...	...	...	...
17—17	1,430	...	...	...	...	...
2—4	800	...	...	...	...	...
1—2	1,500	...	...	...	...	...
2—3	1,100	...	...	...	...	...
1—3	1,386	...	...	...	...	...
74—75	1,100	...	...	...	...	...
47—64	..	...	...	...	1,584	...
48—65	...	..	...	...	1,606	...
49—68	...	...	...	1,584	...	...
50—69	...	...	1,584	...	...	...
51—70	...	...	1,452	...	...	...
52—71	...	...	1,760	...	...	...
53—72	...	682	...	...	...	...
73—91	...	2,222	...	...	...	...
74—93	1,100	...	...	...	...	...
74—74	845	...	...	...	...	...
73—74	660	...	...	...	...	...
55—73	2,200	...	...	...	...	...
53—73	1,100	...	...	...	...	...
53—54	1,496	...	...	...	...	...
53—53	1,100	...	...	...	...	...
52—53	1,540	...	...	...	...	...
32—52	1,342	...	...	...	...	...
52—52	1,550	...	...	...	...	...
51—52	1,112	...	...	...	...	...
31—51	1,276	...	...	...	...	...
30—50	1,320	...	...	...	...	...
29—49	1,210	...	...	...	...	...
49—49	1,400	...	...	...	...	...
Carried over ...	1,05,493	8,439	15,258	4,532	6,446	8,562

Estimate of pipes required for domestic water supply distribution scheme—contd.

Name of pipe.	Diameter of pipes.					
	3-inch.	4-inch.	5-inch.	6-inch.	7-inch.	8-inch.
	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.
Brought forward ...	1 05,493	8,439	15,258	4,532	6,446	8,562
49— 50	1,100	...	...	...	...	...
48— 49	1,540	...	...	...	...	...
67— 68	...	...	1,584	...	...	...
69— 85	...	...	1,804	...	...	...
70— 86	...	...	1,672	...	...	...
71— 89	...	1,826	...	...	...	...
71— 72	...	352	...	...	...	...
89— 90	...	1,078	...	...	...	...
91— 92	...	2,420	...	...	...	...
91— 93	572	...	...	...	...	...
93— 93	770	...	...	...	...	...
93—115	1,100	...	...	...	...	...
92—114	2,200	...	...	...	...	...
88— 92	823	...	...	...	...	...
88— 89	2,090	...	...	...	...	...
86— 87	1,892	...	...	...	...	...
84— 85	2,068	...	...	...	...	...
67— 83	...	1,848	...	...	...	...
66— 67	...	1,210	...	...	...	...
27— 47	1,254	...	...	...	...	...
28— 48	1,232	...	...	...	...	...
47— 48	1,496	...	...	...	...	...
47— 47	1,420	...	...	...	...	...
48— 48	1,420	...	...	...	...	...
64— 65	1,320	...	...	...	...	...
64— 80	1,870	...	...	...	...	...
64— 64	1,725	...	...	...	...	...
65— 66	2,090	...	...	...	...	...
100—101	...	880	...	...	...	...
103—120	...	2,420	...	...	...	...
103—103	1,430	...	...	...	...	...
103—104	1,980	...	...	...	...	...
104—104	1,650	...	...	...	...	...
104—104	1,430	...	...	...	...	...
Carried over ...	1,40,965	20,473	20,318	4,532	6,446	8,562

Estimate of pipes required for domestic water supply distribution scheme—contd.

Name of pipe.	Diameter of pipes.					
	3-inch.	4 inch.	5-inch.	6-inch.	7-inch.	8-inch.
	Feet	Feet.	Feet.	Feet	Feet.	Feet.
Brought forward ...	1,40,965	20,473	20,318	4,532	6,446	8,562
104—122	2,825	...	...	...	...	...
121—122	...	2,266	...	...	...	...
122—122	960	...	...	...	...	...
122—122	1,606	...	...	...	...	...
122—123	1,144	...	...	...	...	...
135—136	...	1,210	...	...	...	...
Oce 135	7,612	...	...	...	...	...
142—143	792	...	...	...	...	...
134—142	1,232	...	...	...	...	...
138—139	1,210	...	...	...	...	...
124—143	1,166	...	...	...	...	...
143—150	1,584	...	...	...	...	...
105—123	2,508	...	...	...	...	...
123—123	1,584	...	...	...	...	...
123—124	2,376	...	...	...	...	...
124—151	2,684	...	...	...	...	...
124—125	2,033	...	...	...	...	...
124—124	1,980	...	...	...	...	...
124—124	1,980	...	...	...	...	...
137—138	1,210	...	...	...	...	...
133—142	726	...	...	...	...	...
98—99	880	...	...	...	...	...
80—81	1,760	...	...	...	...	...
66—82	1,914	...	...	...	...	...
81—103	...	...	...	1,375	...	...
81—82	1,826	...	...	...	...	...
82—82	1,900	...	...	...	...	...
82—104	...	...	...	2,354	...	...
82—83	1,782	...	...	...	...	...
104—105	1,342	...	...	...	...	...
99—100	...	...	...	880	...	...
83—83	1,570	...	...	...	...	...
83—84	1,355	...	...	...	...	...
105—105	1,530	...	...	...	...	...
Carried over ...	1,93,036	23,949	20,318	9,141	6,446	8,562

Estimate of pipes required for domestic water supply distribution scheme.—contd.

Name of pipe.	Diameter of pipes.					
	3-inch.	4-inch.	5-inch.	6-inch.	7-inch.	8-inch.
Brought forward ...	Feet. 1,93,036	Feet. 23,949	Feet. 20,318	Feet. 9,141	Feet. 6,446	Feet 8,562
105—106	1,716	...	...	...	...	...
84—106	...	...	...	1,650	...	...
107—108	...	...	...	858	...	...
84— 87	726	...	...	...	...	...
108—109	858	...	...	...	...	...
106—125	2,134	...	...	...	...	...
107—112	858	...	...	...	...	...
125—125	2,355	...	...	...	...	...
125—152	1,760	...	...	...	...	...
125—153	1,364	...	...	...	...	...
111—112	858	...	...	...	...	...
109—110	...	858	...	...	...	...
110—111	...	858	...	...	...	...
87—113	1,364	...	...	...	...	...
88—113	2,288	...	...	...	...	...
113—113	4,100	...	...	...	...	...
113—153	1,254	...	...	...	...	...
126—153	1,320	...	...	...	...	...
113—154	4,554	...	...	...	...	...
113—114	2,464	...	...	...	...	...
114—114	2,200	...	...	...	...	...
114—129	2,200	...	...	...	...	...
114—115	1,430	...	...	...	...	...
115—130	1,100	...	...	...	...	...
115—115	924	...	...	...	...	...
87— 87	1,232	...	...	...	...	...
33— 54	2,002	...	...	...	...	...
33— 33	1,650	...	...	...	...	...
32— 33	1,320	...	...	...	...	...
34— 34	1,254	...	...	...	...	...
83—105	...	...	...	2,200	...	...
P— 79	...	1,695	...	...	...	...
P— 62	...	2,860	...	...	...	...
24— 62	...	...	4,950	...	...	...
Carried over ...	2,38,321	30,220	25,268	13,849	6,446	8,562

Estimate of pipes required for domestic water supply distribution scheme—
concld.

Name of pipe.	Diameter of pipes.					
	3-inch.	4-inch.	5-inch.	6-inch.	7-inch.	8-inch.
	Feet.	Feet.	Feet.	Feet.	Feet.	Feet.
Brought forward ...	2,83,321	30,220	25,268	13,849	6,446	8,562
62— 62	1,725	...	...	...	...	...
62— 62	1,900	...	...	...	...	...
62— 62	2,070	...	...	...	...	...
79— 79	1,900	...	...	..	...	...
62— 79	...	2,090	...	...	...	...
63— 79	2,035	...	...	...	...	...
62— 63	1,232	...	...	...	...	...
46— 63	...	1,760	...	...	...	...
46— 46	1,570	...	...	...	...	...
26— 46	1,375	...	...	...	...	...
13— 26	1,045	...	...	...	...	...
25— 26	1,126	...	...	...	...	...
45— 46	1,430	...	...	...	...	
24— 45	...	...	1,364	...	...	...
11— 12	3,564	...	...	...	...	...
12— 25	...	...	1,126	...	...	...
12— 13	...	...	1,430	...	...	...
45— 62	1,430	...	...	...	...	...
95— 96	...	880	...	...	...	...
25— 45	1,158	...	...	...	...	...
13— 25	935	...	...	...	...	...
	262,816	34,950	29,188	13,849	6,446	8,562
Allow for bends, etc., 7 per cent.	18,397	2,447	2,043	969	451	599
	281,213	37,397	31,231	14,818	6,897	9,161
Contingencies, broken pipes, etc., 10 per cent.	28,121	3,740	3,123	1,482	690	916
Total feet ...	309,334	41,137	34,354	16,300	7,587	10,077
Weight per foot ..	11·33 lbs.	17·11 lbs.	22·55 lbs.	31·11 lbs.	39·33 lbs.	45·89 lbs.
Total weight in cwts. ...	31,301·⅘	6,284·8	6,918·5	4,527·8	2,664·5	4,128
Say ...	31,300	6,285	6,920	4,530	2,665	4,130

Total weight of pipes 55,830 cwts.
Cost at Rs. 8 per cwt. Rs. 4,46,640.
Say Rs. 4½ lakhs.

Thickness of pipes in distribution system.

Formula for thickness in inches.

$t = \cdot000054\ H\ d + \cdot15\sqrt{d}.$

where H = head in feet.

d = diameter in inches.

The Head is taken as 865 — 690 = 175 feet.

Diameter   Thickness.

3″	$\cdot000054 \times 175 \times 3 + \cdot15\sqrt{3} = \cdot0283 + \cdot2598 = \cdot2881 = \frac{19}{64}''$	Say $\frac{5}{16}''$
4″	$\cdot000054 \times 175 \times 4 + \cdot15\sqrt{4} = \cdot0378 + \cdot300 = \cdot3378 = \frac{11}{32}''$	Say $\frac{11}{32}''$
5″	$\cdot000054 \times 175 \times 5 + \cdot15\sqrt{5} = \cdot0473 + \cdot3355 = \cdot3828 = \frac{25}{64}''$	Say $\frac{3}{8}''$
6″	$\cdot000054 \times 175 \times 6 + \cdot15\sqrt{6} = \cdot0567 + \cdot3675 = \cdot4242 = \frac{7}{16}''$	Say $\frac{7}{16}''$
7″	$\cdot000054 \times 175 \times 7 + \cdot15\sqrt{7} = \cdot0662 + \cdot3969 = \cdot4631 = \frac{15}{32}''$	Say $\frac{15}{32}''$
8″	$\cdot000054 \times 155 \times 8 + \cdot15\sqrt{8} = \cdot0756 + \cdot4243 = \cdot4999 = \frac{1}{2}$	Say

3″ pipe $\frac{5}{16}''$ thick = 0 Cwt. 3 quarters 18 lbs. per 9 feet = $11\frac{1}{3}$ lbs. per foot.
4″ „ $\frac{11}{32}''$ „ = 1 Cwt. 1 quarter 14 lbs. per 9 feet = $17\frac{1}{3}$ lbs. per foot.
5″ „ $\frac{3}{8}''$ „ = 1 Cwt. 3 quarters 7 lbs. per 9 feet = $22\frac{5}{9}$ lbs. per foot.
6″ „ $\frac{7}{16}''$ „ = 2 Cwts. 2 quarters 0 lbs. per 9 feet = $31\frac{1}{9}$ lbs. per foot.
7″ „ $\frac{15}{32}''$ „ = 3 Cwts. 0 quarter 18 lbs. per 9 feet = $39\frac{1}{3}$ lbs. per foot.
8″ „ $\frac{1}{2}''$ „ = 3 Cwts. 2 quarters 21 lbs. per 9 feet = $45\frac{8}{9}$ lbs. per foot.

APPENDIX E.

Schedule of rates used in this estimate.

	Rs.	A.	P.	
Cast iron pipes laid complete	8	0	0	per cwt.
Cast iron pipes F. O. B. Bombay, etc. ...	5	0	0	per cwt.
Lead and yarn joints, average rate ...	1	0	0	per cwt. of pipes.
Landing and port charges, freight, etc. ...	1	4	0	per cwt.
Unloading at Delhi, carting, excavation, laying and jointing, and filling in, etc. ...	0	12	0	per cwt.
Engines and pumps including all buildings—				
Unfiltered water-supply	1,200	0	0	per H. P.
Filtered water-supply	1,000	0	0	per H. P.
Buildings, *i.e.*, engine and boiler house, workshop, godown, staff quarters, etc.—				
Unfiltered water-supply	300	0	0	per H. P.
Filtered water-supply	250	0	0	per H. P.
Engines and pumps including all pipes inside engine house, boilers, feed water pump, economiser, superheater, travelling overhead crane, spare parts, etc., etc.—				
Unfiltered water-supply	900	0	0	per H. P.
Filtered water-supply	750	0	0	per H. P.
Telephone line (rent capitalised at 4 per cent)...	606	0	0	per mile.
Telephone instruments (rent capitalised at 4 per cent.)	1,350	0	0	each.
Settling tanks, intermittent type	10	0	0	per 1,000 gallons.
Clear water reservoir	50	0	0	per 1,000 gallons.
Sand filter beds	1	0	0	per square foot.

Lump sum items.

	Rs.
River training works	1,00,000
Intake	40,000
Suction well	8,000
Valves, metres, etc., on unfiltered water-supply— ...	10,000
At filters, etc.	50,000
On rising main	15,000
On distribution	1,00,000
Sandwasher at filter beds	3,500
Tramway	10,000
Roads at site	10,000
Fencing site	3,500
Preliminary expenses	12,000

Water-supply 30 gallons per head per day for europeans.

15 gallons per head per day for indians.

250,000 gallons per day for cantonments.

Rate of filtration 30 gallons per square foot per 24 hours.

Period of absolute rest in settling tanks 32 hours.

Duration of pumping 16 hours per day.

Velocity of water in pipes 3 feet per second.

Maximum rate of consumption = twice average rate.

Proportional cost to—

New capital	$\frac{1}{4}$, $\frac{4}{8}$ or 1.
Cantonments	$\frac{1}{8}$, $\frac{1}{8}$
Indian city	$\frac{5}{8}$

G. C. B. P., Simla.—No. 708 H. D.—15-11-12.—55—N.C.

ESTIMATE No. V.

Roads ... ... Rs. 24,38,105.

708HD

Report, dated 21st September 1912, by Captain W. H. Roberts, R.E., on the cost of roads.

CONTENTS.

The above plans are in a separate cover.

Report, dated 21st September 1912, by Captain W. H. Roberts, R.E., on the cost of roads.

Provision in estimate.

These estimates provide for the cost of constructing all avenues and roads within the limits of the new capital. They include the roads from Humayun's tomb to the Flagstaff on the Ridge, but exclude the roads in the indian city extension and those to the west and south of the road along the top of the ridge, as these latter roads should be included in the communications of the new cantonment. These estimates are based on the 2nd revised lay-out of Mr. H. V. Lanchester, dated the 30th July 1912.

Alternative estimates.

2. Two estimates have been prepared; one in accordance with the type sections prepared by Mr. H. V. Lanchester, and the other estimate has been based on type sections designed in this office which vary considerably, as will be explained later, from Mr. Lanchester's designs, both in detail and in width.

Specifications.

3. The estimate for Mr. Lanchester's designs is based on the specification of the committee for the main avenue, whereas the alternative proposals follow the more usual indian specifications of the Public Works Department and the Military Works Services.

The committee in their specification for the main avenue allow for a soling coat of 10 inches, and a metalling coat of 6 inches. The usual indian practice is to allow for a soling coat of 6 or 4½ inches, with a metalling coat of 6 or 4½ inches. The alternative estimate is based on a 6-inch soling coat and 4½ inches of metalling, except in the case of one class where 6 inches of metalling has been allowed for.

4. Each estimate consists of three parts—

(a) Metalled surface, riding tracks, grass, trees, foot-paths, etc.

(b) Earth and rock cutting and filling.

(c) Culverts.

Details of (a) for mile lengths of the various roads and avenues are given, in statements A and B for Mr. Lanchester's roads and those proposed, respectively. It should be noted that these estimates include in every case 2½ feet of earth cutting and filling, and that estimate (b) contained in statements C and D contain earth and rock work below 2½ feet. Estimate (c) for culverts is contained in statements K and L. The culverts for the widths of roads as given by Mr. H. V. Lanchester will cost Rs. 6,90,388, and those for the widths proposed Rs. 5,22,917.

5. The following remarks are added in amplification of the attached tables and to bring to notice some of the chief points that require attention.

240 feet main avenues.—Mr. Lanchester proposes one roadway in the centre, 64 feet wide with 35 feet of metalling, on both sides are riding tracks, grass plots and foot-paths.

This type does not seem altogether suitable as the actual metalled roadway is very small in comparison to the width, the wide un-metalled berms are also liable to make the avenue somewhat dusty. The alternative proposal is to reduce the total width to 200 feet and to provide three metalled roadways without any un-metalled berms, the two outer roads for slow traffic being 20 feet wide each, and the centre roadway 30 feet wide for fast traffic. Riding tracks, grass plots and foot-paths are also provided for. A road of this description would be able to take a much larger amount of traffic than that proposed by Mr. Lanchester, and would have the advantage of having no un-metalled berms.

150 feet wide avenues.—Mr. Lanchester's type design is much the same as that for the 240 feet avenues, the roadway is exactly the same, but the space for paths, riding tracks and grass has been reduced. The total width of this

class appears somewhat great. It is, therefore, proposed to replace this type by one with a width of 80 feet.

120 feet wide avenues.—No section has been prepared for this width of road, but it is proposed to reduce the width to 80 feet.

80 feet wide avenues.—Mr. Lanchester proposes a roadway of 32 feet with 20 feet of metal with riding tracks, paths, grass, etc. The amount of metalled roadway appears to be insufficient, the road would also be somewhat dusty with its un-metalled berms. It is, therefore, proposed to substitute for the 150 feet, 120 feet and 80 feet avenues of Mr. Lanchester a new design for a width of 80 feet. The main feature of this design is that it will consist of a broad metalled surface of 32 feet divided in the centre by a line of lamp posts or other suitable devise. This proposed road would be able to take a larger amount of traffic than the roads designed by Mr. Lanchester, and would not be so dusty as they avoid unmetalled berms.

60 feet wide avenues.—Mr. Lanchester proposes a width of 60 feet for the more unimportant roads. The width of the actual roadway is 32 feet with 20 feet of metalling. The total mileage of these roads is about 57 miles, and it would appear hardly necessary to make the width of the roads for this number of miles as great as 60 feet, as many of the roads will be laid where there is very little wheeled traffic. It is, therefore, suggested that the width of some of the roads be reduced to 50 feet and 40 feet. Type designs for these widths have been shown in the alternative estimate.

Service roads.—These roads are chiefly required for conservancy purposes, and will be situated at the back of the various blocks of buildings. The suggested width is 12 feet from outside to outside of side drain. 9 inches of metalling is proposed.

Widths of roads.

6. The widths of the avenues and roads is an important point both as regards economy in construction, maintenance, and the amount of land taken up. Statement G attached shows that the roads as suggested by Mr. Lanchester will occupy 1,115 acres, while the alternative proposals would occupy a space of 896 acres, thus showing a saving of 219 acres.

Excavation and filling.

7. Statements C and D show the total amount of earth and rock work in excess of 2½ feet which is included in the estimate per mile length of road. The former statement shows that the amount of rock cutting is about 11,550,000 cubic feet. Statements E and F show that the amount of stone work required for the roads will be about 17,350,000, and 13,003,444 cubic feet according as to which estimate is being considered. These figures, therefore, show that all the rock excavated can be used for metalling, provided that it is of good enough quality. The statements further show that the construction of a road through the Rai Sina Hill will present no difficulties. The amount of rock cutting for a 240 feet wide avenue is about 5,000,000 cubic feet. The whole of this rock would be used for metalling stone. The estimate for excavation, therefore, makes no provision for rock as the quarrying of it is included in the rate for soling and metalling. An all-round rate of Rs. 6 per 1,000 cubic feet has been taken for excavation, filling and a lead of up to 300 feet. The total amount of earthwork is estimated at Rs. 3,44,403 for the widths of roads as given by Mr. Lanchester, with the reduced widths the cost would be Rs. 2,27,007 (statement D).

Culverts.

8. Statement H shows the number and sizes of culverts that will be required to bridge the nullahs and storm-water channels. The lay-out is in several places not altogether suitable as regards economy in the disposal of storm-water. For instance a large nullah cuts right through the junction of several roads at point H. Unless the plan was modified this would necessitate a sewer or conduit for a length of 1,500 feet and with a section of 240 sq. feet. Such an underground conduit would cost about Rs. 1,25,000. The road G to C for 1,500 feet runs along the bottom of a nullah, which is an important drainage channel, and unless the position of this road can be altered

a conduit of a section of 225 sq. feet will be necessary, costing also about Rs. 1,25,000. The road G to U for a length of 5,000 feet also runs in a nullah bed; in this case the nullah could be re-aligned at a cost of about Rs. 10,000. These amounts are not, however, included in the estimate. Between Baburpur village, which is at the head of the main drain, and the river, there will be at least three 100 feet culverts. The roads cross this drain in all five times, but by slight alterations the number of culverts would be reduced to three.

Statement J shows clearly the cost of each class of culvert proposed for both of the alternative estimates.

Total cost.

9. The total cost of the roads, according to the designs by Mr. H. V. Lanchester, will be Rs. 31,86,380 (*vide* statement M), and for the reduced and alternative proposals the total cost will be Rs. 24,38,105 (*vide* statement N).

Points upon which orders are required.

10. The following points need consideration before a detailed project can be prepared.

(*a*) To what extent the ridges should be adhered to to secure convenient and economic drainage and irrigation arrangements at perhaps the expense of the æsthetics obtained from a geometrical lay-out. If the roads be aligned more or less along the ridges, the bridging and drainage will be considerably cheapened.

(*b*) To what extent roads and avenues should be constructed at once, or be deferred to the future. For example, it may not be considered necessary to construct at once the road from Humayun's tomb to the Flagstaff which passes through the Bela, and would probably require expensive works to prevent the encroachment of the river. Also it may not be considered necessary to construct for the present metalled roads through the park land, and to certain building plots reserved for future expansion. It is understood that arrangements will be made for the afforestation of the ridge, this being so, it may be considered desirable to postpone the construction of roads upon the ridge and to exclude the public until the trees are well established.

(*c*) The extent of roads that should be included in the detailed project. This estimate excludes all new roads within the present city and those of the indian city extension, as it is probable that the construction of these roads will be included in a separate estimate for city developments. The roads to the west of the main ridge road are also excluded as they also form part of the estimate for the cantonment.

(*d*) The alignment of the roads, and the maximum permissible gradients for each class of road.

(*e*) Cross section of each type of road, *i.e.*, width, arrangements of paths, avenues, grass, etc.

(*f*) *Specifications.*—Under this heading information will be required as to the use to be made of stone and kankar, tar, oil and other materials that are used in road construction.

Concentration of information.

10. In this report, and in the plans and estimate, an endeavour has been made to reproduce only the absolutely necessary information. Should any department of the Government of India require any further elucidation on any point, a reference can be made to the officer dealing with the subject, who can also attend and give any necessary explanations.

Appendices A and B.

Appendix A is a schedule of rates that have been used in this estimate, and Appendix B is a forecast of the annual expenditure that will be incurred on the road during the time of construction of the new capital.

STATEMENT A.

Estimated cost of Mr. H. V. Lanchester's type roads per mile, exclusive of culverts, bridges, etc.

Nature of Work.	Rate.				DETAIL OF COST PER MILE.											
					Service Roads.		60 feet Roads.		80 feet roads.		120 feet roads.		150 feet road.		240 feet avenue.	
					Quantity.	Cost.	Quantity.	Cost.	Quantity.	Cost.	Quantity.	Cost.	Quantity.	Cost.	Quantity.	Cost.
	Rs.	A.	P.	Per.	c. ft.	Rs.	c. ft.	Rs.	c. ft.	Rs.	c. ft.	Rs.	c. ft.	Rs.	c. ft.	Rs.
Earthwork	3	8	0	0/00 c. ft.	166,320	582	792,000	2,772	1,056,000	3,696	1,320,000	4,620	1,980,000	6,930	3,168,000	11,088
*Soling coat (10")	5	8	0	% c. ft.	23,760	1,307	88,000	4,840	88,000	4,840	154,000	8,470	154,000	8,470	154,000	8,470
*Metalling (6")	7	10	0	% c. ft.	17,820	1,359	52,800	4,026	52,800	4,026	92,400	7,045	92,400	7,045	92,400	7,045
Dressing earth berms ..	1	4	0	% r. ft.	..	..	5,280	66	5,280	66	..	..	10,560	132	10,560	132
Footpaths .. { Ballast ..	7	10	0	% c. ft.	..	..	15,840	1,208	15,840	1,208	26,400	2,013	26,400	2,013	137,280	10,468
Footpaths .. { Bujri ..	15	0	0	% c. ft.	..	..	2,640	396	2,640	396	4,400	660	4,400	660	22,880	3,432
Grass	1	0	0	% sq. ft.	..	..	84,480	845	190,080	1,901	179,520	1,795	179,520	1,795	211,200	2,112
Trees	3	0	0	each.	..	..	352	1,056	704	2,112	704	2,112	704	2,112	1,408	4,224
Riding paths	0	8	0	% sq. ft.	..	..	..	..	..	..	168,960	845	168,960	845	168,960	845
Curbs	2,310	0	0	p. m.	..	..	..	..	..	..	..	..	..	..	10,560	4,620
Cost per mile ..	..			..	..	3,248	..	15,209	..	18,245	..	27,560	..	30,002	..	52,436

*Dimensions taken from Committee's cross section of main avenues.

STATEMENT B.

Estimated cost of proposed alternative type roads per mile, exclusive of culverts, bridges, etc.

Class of work.	Rate.		12 FEET SERVICE ROADS.		40 FEET ROADS.		50 FEET ROADS.		60 FEET ROADS.		80 FEET AVENUE.		200 FEET AVENUE.	
			Quantity.	Cost.	Quantity.	Cost.	Quantity.	Cost.	Quantity.	Cost.	Quantity.	Cost.	Quantity.	Cost.
	Rs. A. P.	Per.	c. ft.	Rs.	c. ft.	Rs.	c. ft.	Rs.	c. ft.	Rs.	c. ft.	Rs.	c. ft.	Rs.
Earthwork	3 8 0	0/00 c. ft.	166,320	582	528,000	1,848	660,000	2,310	792,010	2,772	1,056,000	3,696	2,640,000	9,240
Soling coat (6″)	5 8 0	% c. ft.	23,760	1,307	47,520	2,614	52,800	2,904	52,810	2,904	84,480	4,646	184,800	10,164
Metalling (4½″)	7 10 0	% c. ft.	17,820	1,359	35,600	2,714	39,600	3,019	39,610	3,020	84,480	6,412	138,600	9,789
Dressing earth berms ..	1 4 0	% r. ft.	..	..	..	30	..	30	5,280	66	..	..	..	..
Footpaths .. { Ballast ..	7 10 0	% c. ft.	..	..	13,200	1,089	13,200	1,089	13,200	1,089	15,840	1,208	34,320	2,617
Footpaths .. { Bujri ..	15 0 0	% c. ft.	..	..	2,200	182	2,200	182	2,200	182	2,640	396	5,720	858
Grass	1 0 0	% sq. ft.	..	..	42,240	422	73,920	739	82,460	845	73,920	739	348,480	3,485
Trees	3 0 0	each.	..	..	352	1,056	352	1,056	352	1,056	352	1,056	704	2,112
Riding track	0 8 0	% sq. ft.	..	..	..	..	..	..	..	..	105,600	528	190,080	950
Curbs	2,310 0 0	mile.	..	..	..	..	..	..	..	..	10,560	4,620	31,680	13,860
Cost per mile ..	..	..	..	3,248	..	9,955	..	11,329	..	11,934	..	23,331	..	53,075

STATEMENT C.

Roads and avenues as dimensioned by Mr H V Lanchestc

Statement showing the amount of earth and rock work.

Class of Road	Name of Road.	Earth 1st lift 0—5 feet	Earth 2nd lift 5—10 feet	Earth 3rd lift 10—15 feet	Rock 1st lift 0—5 feet	Rock 2nd lift. 5—10 feet	Rock 3rd lift 10—15 feet	Totals cubic feet.
240 feet avenue	O to Q	250			.			
	C to D . .	3,500	200					
	C to B ..	700	.					
	C to H ..	200			1,500	1,700	900	
		4,650×5×243⅓	200×5×246⅔		1,500×5×243⅓	1,700×5×216⅔	900×5×250	
		5,657,500	246,666		1,824,975	1,849,950	1,125,000	10,704,091
150 feet avenue	G to H .	2,000				.		
	H to O	2,300						
	O to Muttra Road	300	100	.	400	400	.	
	O to Race Course stand	900		.	.		.	
	O to Muttra Road	200	.	.	400	200	.	
	Part of H to Purana Kila	1,300			200			
	B to O	550				.		
		2,550×5×153⅓	100×5×156⅔		1,000×5×153⅓	600×5×156⅔		
		5,788,330	78,330		766,650	469,980		7,103,293
80 feet avenue	G to C	1,800	200					
	G to M	1,600						
	3rd circular road Safdar Jan	1,600	200		..		.	
	105 to U .. .	1,000		..		.	.	
	H to V . .	3,700	.	..		..	..	
	Circle at Zabta Ganj	1,100	.			.	..	
	Circle at O .	2,400	300	.	500	..	..	
	15 to F .. .	2,100	..	.	.	..	..	
	F to A . ..	2,000	..	..	..	..	..	
	C to 92-113	1,000	.	.	..	..	..	
	C to Idgah ..	900		..	200	.	.	
	C to K . .	100	..	.	3,500	.	.	
	14 to 121 ..	300	.	.	.	..	..	
	M to N	100	..	..	..	..	..	
	Part of H to B ..	300	.	.	.	..	..	
		20,000×5×83⅓	700×5×86⅔	.	4,200×5×83⅓	..	.	
		8,333,333	303,310	..	1,749,993	Carried over	.. ..	10,386,636 28,194,020

Roads and avenues as dimensioned by Mr. H V. Lanchester

Statement showing the amount of earth and rock work.

Class of Road	Name of Road.	Earth			Rock			Total.
		1st lift 0—5 feet	2nd lift 5—10 feet	3rd lift 10—15 feet	1st lift 0—5 feet	2nd lift 5—10 feet	3rd lift 10—15 feet.	Cubic feet.
						Brought forward		28,194,0?0
60 feet avenues	G to Arakpur	900	300		500	500	500	
	G to Bheron ka Mander	500						
	G to E	1,200			600	600	300	
	G to D	50			250	250	250	
	G to 17	250						
	74 to 32	500						
	G to U	1,800						
	D to edge of map *viá* W	4 900	200	200	600	200	200	
	2nd circular road around Government House	3,000						
	3rd circular road around Government House	2,400						
	4th circular road around Government House	6,100						
	Y to edge of map (NW)	2,200			2,200	300		
	From 1st circular road to W	3,500			1,000			
	1st circular road	4,000	300		500			
	From circular avenue to D E and edge of map	400						
	27/28 to junction with B O	1,100	300	300				
	V to Flagstaff	1,700	200					
	Boring No 2 to Paharganj	600						
	5th circular road Raja ka Bazar to second circle round Safdar Jang	1,400						
	Y to R	400						
		37,700×5×63⅓	1,800×5×66⅔	500×5×70	8,450×5×63⅓	1,950×5×66⅔	1,250×5×70	
		11,938,333	600,000	175,000	2,675,833	650,000	437,500	16,476,666
60 feet avenues	These roads will bisect many of the larger plots, and are not shown on the map. The total length is estimated at 6 miles. The average amount of earthwork may be taken as $\frac{16,476,666}{52,12}$ c ft per mile = 316,129 c ft For six miles							1,896,774 cubic feet.
12 feet service roads.	These service roads are not shown on the map, the total length is estimated at 30 miles The amount of earthwork per mile will be 1-5th of that for a 60 foot road or $\frac{316,129}{5}$ c ft For 30 miles ..							1,898,774 ,,
	Grand total c ft. ..							48,464,234 ,,
	Rock excavation c ft. ..							11,549,881 ,,
	Earthwork c ft. ..							36,914,353 ,,

Estimate.

After rock cutting has been used for metalling, it will not cost more than Rs 6 per 100 c. ft. To cover small irregularities of the ground add 15 per cent to the total of 48,464,234 c ft

Quantity c ft.	Rate	Per	Cost.
	Rs		Rs.
59,733,869	6	0,100 c ft.	3,44,403

STATEMENT D.

Statement showing the amount of earth and rock work for proposed width of roads.

(*Note.*—This statement is based on figures in Statement C.)

Class of road.	Earth.			Rock.			Total cubic feet.
	1st lift. 0—5 feet.	2nd lift. 5—10 feet.	3rd lift. 10—15 feet.	1st lift. 0—5 feet.	2nd lift. 5—10 feet.	3rd lift. 10—15 feet.	
200 feet	4,650 × 5 × 203⅓	200 × 5 × 206⅔	..	15,000 × 5 × 203⅓	1,500 × 5 × 206⅔	900 × 5 × 210	
Total ..	4,727,500	206,666	..	1,525,000	1,550,000	945,000	8,934,166
80 feet	7,550 × 5 × 83⅓	100 × 5 × 86⅔	..	1,000 × 5 × 83⅓	600 × 5 × 86⅔	..	..
Total ..	3,145,800	43,333	..	433,333	260,000	..	3,882,466

Class of road.		Total cubic feet.
60 feet ..	All the 80 feet roads of Mr. Lanchester's proposals will be reduced to 60 feet, thus saving ¼ of 10,386,676 *c. ft.* or 2,596,639 *c.ft.* therefore quantity of earth and rock=	7,789,977
50 and 40 feet	Some of the 60 feet roads of Mr. Lanchester will remain 60 feet wide, and other will be reduced to 50 and 40 feet. The total saving may be taken as being ⅙th of 18,373,440 *c.ft.* or 3,062,240 therefore quantity of earth and rock = ...	15,311,200
12 feet ..	.. As in detailed statement C. for 12 feet roads	1,896,774
	Total ..	37,834,583*

* 37,834,583 *c.ft.* @ Rs. 6 per 1,000 cubic feet costs Rs. 2,027,007.

STATEMENT E.

Statement showing the lengths of roads in Mr. H. V. Lanchester's 2nd revised lay-out and amount of soling and metalling required.

Width of avenue or road.	Length.		Amount of soling and metalling.		Remarks.
	In feet.	In miles.	Per mile in c. ft.	Total. c. ft.	
240 feet	43,200	8·18	246,400	2,015,532	
150 feet	40,200	7·61	246,400	1,895,104	
120 feet	7,600	1·44	246,400	354,816	
80 feet	136,963	25·94	140,800	3,652,352	
60 feet	306,874	58·12	140,800	8,183,296	Includes 6 miles not shown on plan.
12 feet	158,400	30·00	41,580	1,247,400	Not shown on plan.
Total ..	..	131·29	..	17,348,520	

The figure 17,348,530 *c.ft.* assumes that the soling coat for all roads will be 10 inches, and the metalling 6 inches as in the specification of the Committee for the main avenue.

If the soling be 6″ thick, and the average thickness of the metalling 4½″, the amount of soling and metalling will be reduced to 11,384,966 cubic feet.

STATEMENT F.

Statement showing the lengths of the alternative type roads proposed and the amount of soling and metalling required.

—	Length.		Quantity of soling and metalling.		Remarks.
	In feet.	In miles.	Per mile c. ft.	Total c. ft.	
200 feet avenue ..	43,200	8·18	323,400	2,645,412	Substituted for 240′ avenue.
80 feet avenue ..	47,800	9·05	168,960	1,529,088	Substituted for 150 and 120′ avenue.
60 feet road	1,79,837	34·06	92,400	3,147,144	Substituted for 80 feet and 60 feet avenues.
50 feet road	158,400	30·00	92,400	2,772,000	
40 feet road	105,600	20·00	83,120	1,662,400	
12 feet road	158,400	30·00	41,580	1,247,400	
Total ..	..	131·29	..	13,003,444	

The soling coat for all these roads is taken as 6 inches and the metalling 4½ inches (*i.e.*, 6 inches at centre and 3 inches at edges) except in the case of the 80 feet roads when the metalling is taken as 6 inches.

STATEMENT G.

(a) *Statement showing total acreage of roads according to Mr. H. V. Lanchester's 2nd revised lay-out.*

Width of avenue.	Length in miles.	Acres per mile length.	Total acreage.	REMARKS.
240 feet	8·18	29·10	238·11	
150 feet	7·61	18·18	138·34	
120 feet	1·64	14·44	20·93	
80 feet	25·94	9·70	251·61	
60 feet	58·12	7·27	422·53	
12 feet	30·00	1·46	43·80	
Total ..	..	..	1,115·32	

(b) *Statement showing total acreage of roads according to Mr. H. V. Lanchester's 2nd revised lay-out, but with widths of roads and avenues reduced.*

Width of avenue.	Length in miles.	Acres per mile length.	Total acreage.	REMARKS.
200 feet	8·18	29·10	238·11	
80 feet	9·05	9·70	87·78	
60 feet	34·06	7·27	247·61	
50 feet	30·00	6·06	181·80	
40 feet	20·00	4·85	97·00	
12 feet	30·00	1·46	43·80	
Total ..	..	..	896·10	

Note.—The total saving in land obtained by adopting the reduced widths in (*b*) will be 219 acres.

STATEMENT H.

Statement showing the number and sizes of culverts required for roads according to Mr. H. V. Lanchester's 2nd revised lay-out.

Widths of roads in feet.	Name of road.	NUMBER OF CULVERTS. SPANS. 5′	8′	10′	12′	20′	30′	40′	100′
240 feet	C to B	..	..	5	..	..	..	..	..
	C to O	..	..	1	3	..	..	..	..
	C to O	..	..	..	3	..	1	..	..
	O to Q	4	..	..	..	..	..	..	..
	Total ..	4	..	6	6	..	1	..	..
150 feet	G to H	1	..	..	1	..	..	..	1
	H to O	4	..	..	..	..	..	..	..
	H to Muttra Road (3 roads)	6	..	..	..	..	..	..	..
	B to O	5	1	..	..	..	..	..	..
	H to O	4	..	..	..	..	..	..	..
	N to B	1	..	..	..	..	..	..	..
	Total ..	21	1	..	1	..	..	..	1
80 feet	C to G	1	..	1	..	..	1	..	..
	C to Idgah	4	3	..	..	..	..	..	..
	14 to 121	2	1	3	..	..	..	..	..
	C to K	3	1	6	..	..	..	..	..
	C to F	..	1	1	..	..	1	..	..
	C to 113	..	..	1	..	..	..	..	..
	C to 129-154	3	..	3	..	..	1	..	..
	G to N *viâ* M	1	5	..	..	..	..	1	..
	2nd circular road Safdar Jang.	4	1	1	..	..	..	..	..
	3rd ditto ..	4	..	4	..	..	..	..	..
	105 to V	5	..	..	..	..	..	..	..
	H to V	..	..	..	..	..	..	..	2
	Circle at Zabta Ganj ..	..	..	..	..	..	2	..	..
	Circle at O	6	..	..	..	..	..	..	..
	F to A	4	..	..	..	..	..	..	..
	Total ..	37	12	20	..	..	5	1	2

STATEMENT H—*contd.*

Statement showing the number and sizes of culverts required for roads according to Mr. H. V. Lanchester's 2nd revised lay-out—contd.

Widths of roads in feet.	Name of road.	NUMBER OF CULVERTS.							
		SPANS.							
		5'	8'	10'	12'	20'	30'	40'	100'
60 feet	G to Arakpur	6	..	..	..	..	..	..	..
	G to Bheron ka mandar ..	5	..	..	..	..	..	..	..
	G to E	6	..	..	..	..	..	..	..
	G to D	3	2	..	..	..	..	..	..
	G to 17	2	2	..	..	..	1	..	..
	74 to 32	..	1	..	..	..	1	..	..
	G to V	2	..	..	..	..	..	..	..
	D to W	3	1	..	..	..	..	..	..
	2nd circular road around Government House.	5	6	1	..	..	1	..	..
	3rd ditto ..	4	1	2	..	..	1	..	..
	4th ditto ..	1	3	3	..	..	1	..	..
	E to edge of map (N. W.)	8	..	..	..	..	..	..	..
	1st circular road around Government House.	7	2	..	..	..	..	..	..
	From 1st circle to DE ..	5	1	1	..	..	..	..	..
	27-28 to junction with BO	2	1	3	..	..	..	..	..
	V to Flagstaff	5	..	..	..	2	..	..	..
	Boring No. 2 to Paharganj	4	2	..	..	..	..	..	..
	Raja ka bazar to 2nd circle Safdar Jang.	1	3	3	..	..	1	..	..
	G to 9	2	1	1	..	..	..	..	..
	B to Kadam Sharif ..	3	..	..	..	..	..	..	..
	Total ..	74	26	14	..	2	6	..	..
Additional 60 feet	6 miles not shown on map	8	3	2	..	1	..	..	..
12 feet service roads	30 miles not shown on map	45	15	8	..	5	..	..	..

STATEMENT J.

A.

Cost of type culverts to suit the widths of road in Mr. H. V. Lanchester's 2nd revised lay-out.

Widths of Roads.	SPANS. Cost of each culvert.							
	5′	8′	10′	12′	20′	30′	40′	100′
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
240 feet	3,645	..	4,941	6,278	..	18,000	..	..
150 "	2,187	2,430	..	3,750	..	..	..	64,800
80 "	1,279	1,442	1,790	..	..	8,932	10,800	45,360
60 "	1,013	1,142	1,425	..	3,872	7,290	..	..
12 "	324	405	486	..	1,620	..	..	..

B.

Cost of type culverts to suit the reduced widths of roads.

Widths of Roads.	SPANS. Cost of each culvert.							
	5′	8′	10′	12′	20′	30′	40′	100′
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
200 feet	2,875	..	3,985	5,281	..	16,500	..	..
80 "	1,279	1,442	..	2,438	..	..	..	45,360
60 "	1,013	1,142	1,425	..	3,872	7,290	12,150	19,424
50 "	883	992	1,243	..	3,438	6,885	..	..
40 "	753	842	1,061	..	3,005	6,480	..	..
12 "	324	405	486	..	1,620	..	..	..

STATEMENT K.

Statement showing cost of culverts suitable for the roads of Mr. H. V. Lanchester's 2nd revised lay-out.

Dimensions of culvert. Span.	Height from top of key stone to bottom of foundation.	240 feet roads No. of culvert.	Masonry.	Total cost at Rs 30 per % c feet.	150 feet roads No of culvert.	Masonry	Total cost @ Rs. 30 per % c ft	80 feet roads No of culvert	Masonry.	Total cost @ Rs 30 per % c ft.	60 feet roads No of culvert.	Masonry	Total cost @ Rs 30 per % c ft	12 feet roads No of culvert	Masonry	Total cost @ Rs 30 per % c. ft.
Feet	Feet.		C ft.	Rs		C ft.	Rs		C ft.	Rs.		C ft	Rs		C ft	Rs
5	7	4	12,150	14,580	21	7,290	45,927	37	4,266	47,353	82	3,375	83,025	45	1,080	14,580
8	7	..	..	.	1	8.100	2,430	12	4,806	17,302	29	3,807	33,121	15	1,350	6,075
10	8	6	16,470	29,646	..	..		20	5,967	35,802	16	4,752	22,810	8	1,620	3,888
12	10	6	20,925	37,665	1	12,500	3,750	.	.	..	..	..	.	..	..	..
20	14	..	..		.	.	.	.	..	..	3	12,906	11,615	5	5,400	8,100
30	20	1	60,000	18,000	..	..	.	5	29,766	44,659	6	24,300	43,740	..	..	..
40	25	..	..	..	..	..		1	36,000	10,800	..	.	..	..	..	..
100	30	..	..	..	1	216,000	64,800	2	1,51,200	90,720	..	..	..	..	..	..
		Total	..	Rs. 99,891		.	Rs 1,16,907	.		Rs. 2,46,636	..	..	Rs 1,94,311	..	..	Rs. 32,643

Grand total .. Rs. 6,90,388

STATEMENT L.

Statement showing the cost of culverts suitable for the alternative proposats with reduced width of roads.

Dimensions of culverts Span	Height from top of kev stone to bottom of foundations.	200 feet roads No of culverts.	Masonry c ft.	Total cost @ Rs 30 per % c. ft	80 feet roads No of culverts	Masonry	Total cost @ Rs. 30 per % c. ft.	60 feet roads No of culverts	Masonry	Total cost @ Rs 30 per % c. ft	50 feet roads. No. of culverts.	Masonry	Total cost @ Rs. 30 per % c ft.	40 feet roads. No of culverts	Masonry	Total cost @ Rs 30 per % c ft.	12 feet roads No of culverts	Masonry	Total cost @ Rs 30 per % c. ft.
Feet.	Feet.		C ft.	Rs.		C.ft	Rs		C ft	Rs		C.ft	Rs		C.ft	Rs		C ft.	Rs
5	7	4	9,585	11,502	21	4,266	26,876	42	3,375	42,525	42	2,943	37,082	35	2,511	26,366	45	1,080	14,580
8	7	.			1	4,806	1,442	15	3,807	17,132	15	3,307	14,882	11	2,808	9,266	15	1,350	6,075
10	8	6	13,284	23,911		.	.	14	4,752	19,958	14	4,144	17,405	8	3,537	8,489	8	1,620	3,888
12	10	6	17,604	31,687	1	8,127	2,438	.	.	..	..	.	.	..	..			.	
20	14							1	12,906	3,872	1	11,461	3,438	1	10,017	3,005	5	5,400	8,100
30	20	1	55,000	16,500			.	4	24,300	29,160	4	22,950	27,540	3	21,600	19,440	.	..	
40	25	..	..	.			..	1	40,500	12,150		.	.	.	..	.		..	..
100	30	.		.	1	1,51,200	45,360	2	64,746	38,848	..	.	.	..	..	..		..	..
	Total ..	.	..	Rs 83,600	.		Rs. 76,116	.	..	Rs 1,63,645	.	..	Rs.1,00,347		..	Rs 66,556		..	Rs. 32,643

Grand total Rs 5,22,917

STATEMENT M.

Abstract of the cost of avenues and roads as designed by Mr. H. V. Lanchester.

Width of road or avenue.	Length in miles.	Cost per mile.	Total.	REMARKS.
Feet.		Rs.	Rs	
240	8·18	52,436	4,28,926	Cost per mile taken from Statement A.
150	7 61	30,002	2,26,315	
120	1 44	27,560	39,686	
80	25 94	18,245	4,73,275	
60	58 12	15,209	8,83,947	
12	30 00	3,248	97,440	
		Total ..	21,51,589	
Cost of excavation in earth and rock ..			3,44,403	See Statement C.
Cost of culverts			6,90,388	See Statement K.
		Grand total Rs.	31,86,380	

STATEMENT N.

Abstract of the cost of avenues and roads as proposed.

Width of road or avenue.	Length in miles.	Cost per mile.	Total.	REMARKS
Feet.		Rs.	Rs.	
200	8·18	53,075	4,34,153	Cost per mile taken from Statement B.
80	9·05	23,331	2,11,146	
60	34·06	11,934	4,06,472	
50	30 00	11,329	3,39,870	
40	20 00	9,955	1,99,100	
12	30·00	3,248	97,440	
		Total ..	16,88,181	
Cost of excavation in earth and rock @ Rs. 6 ‰ 37,834,583 c. ft.			2,27,007	See Statement D.
Culverts			5,22,917	See Statement L.
		Grand total ..	24,38,105	

APPENDIX A.

Schedules of rates used in the estimate.

Item.	Rate. Rs. A. P.	Per.	Remarks.
Earthwork.			
1. Earth excavation and filling in easy soil, not exceeding $2\frac{1}{2}$ feet of cutting	3 8 0	1,000 c. feet	
2. Earth excavation and filling with excavation exceeding $2\frac{1}{2}$ feet .	6 0 0	Ditto.	
Road work.			
3. Laying and consolidating soling coat complete	5 8 0	100 c. feet ..	Includes carriage for $1\frac{1}{2}$ miles.
4. Laying and consolidating $2\frac{1}{2}$ inches metal complete	7 10 0	Ditto ..	Ditto.
5. Dressing earth berms	1 4 0	Ditto ..	Each berm not exceeding 12 feet in width.
6. Collecting and spreading local bujri	15 0 0	100 c. feet.	
7. Stone curb to footpaths ..	2,310 0 0	mile ..	12 inches broad, 6 inches high with a concrete foundation.
Masonry.			
8. As for culverts of brick or coursed rubble in lime mortar ..	30 0 0	100 c. feet ..	An all round rate which includes earth work, foundations, piers, arches, etc.
Miscellaneous.			
9. Planting grass plots	1 0 0	100 s. feet ..	Includes cost of grass and levelling.
10. Planting trees	3 0 0	each ..	Include 0-8-0 for each tree and Rs. 2-8-0 for protection.
11. Riding paths	6 8 0	100 s. feet ..	Includes levelling and preparation of surface.

APPENDIX B.

Programme of annual expenditure.

To facilitate the progress of works and with the object of constructing the roads in the most economical manner a definite policy of road construction should be prepared. In the first instance it will be only necessary to lay the soling coat and a thin layer of metalling, unless it is contemplated to use any particular road for heavy traffic, in which case it would be necessary to lay the full coat of metal.

But by an extensive use of tram lines the traffic on the roads would not be heavy. Therefore the first item of road construction should be to complete all the earth and rock work and to construct the necessary culverts. Then the soling coats and a layer of metal can be laid when required and as soon as the building work on any avenue or road is completed, the road work also can be finished off. The planting of trees should, however, be undertaken at as an early a date as possible.

2. The attached schedule is based on a total expenditure of Rs. 24,30,000 which is the amount of the smaller of the two alternative estimates, as this estimate is considered to be a nearer approximation to the final estimate than the one for Rs. 31,86,000.

Programme of annual expenditure on roads and building.

Nature of work.	Approximate cost.	EXPENDITURE IN EACH YEAR.					
		1912-13.	1913-14.	1914-15.	1915-16.	1916-17.	1917-18.
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Earth and rock work	2,27,000	..	2,27,000	..	..	..	..
Culverts ..	5,23,000	..	2,00,000	3,23,000	..	..	..
Soling, part metalling and planting trees	8,80,000	..	2,00,000	3,00,000	3,80,000	..	.
Final coat of metal and completing roads and avenues	8,00,000	..	..	1,00,000	3,00,000	3,00,000	1,00,000
Total Rs. .	24,30,000	..	6,27,000	7,23,000	6,80,000	3,00,000	1,00,000

G. M. Press, Simla.—No. 269 H. D.—23-10-12.—50.—M.D.

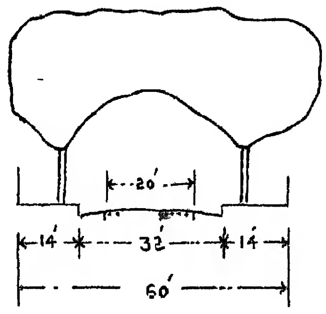
CROSS SECTIONS OF AVENUES TO ACCOMPANY

MR. H. V. LANCHESTERS LAYOUT

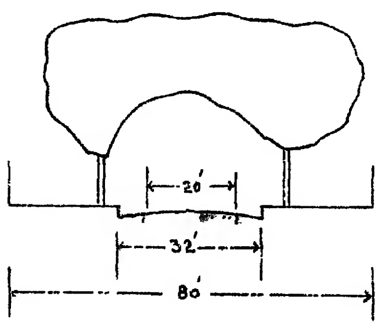
OF

30TH JULY 1912

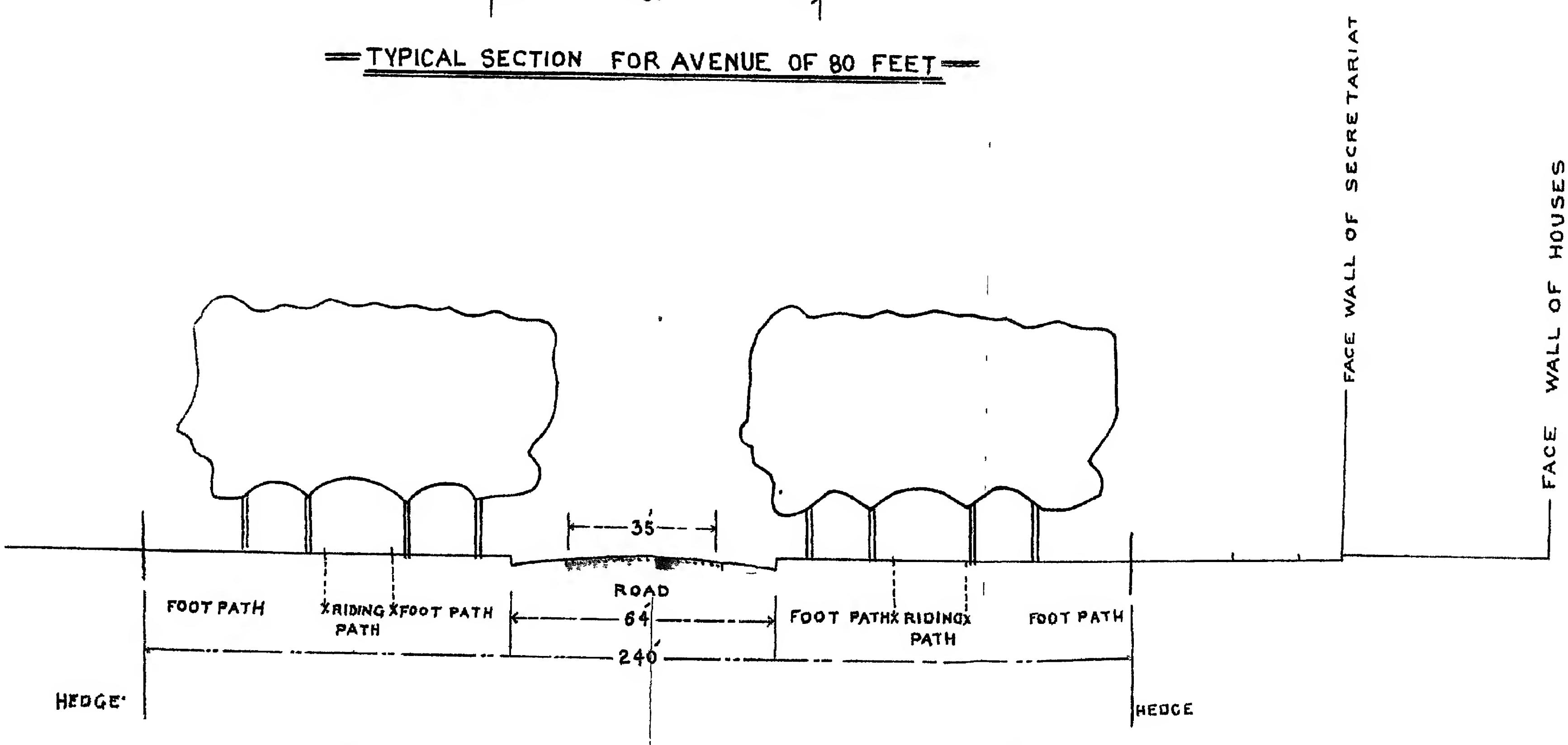
SCALE 32 FEET TO THE MILE



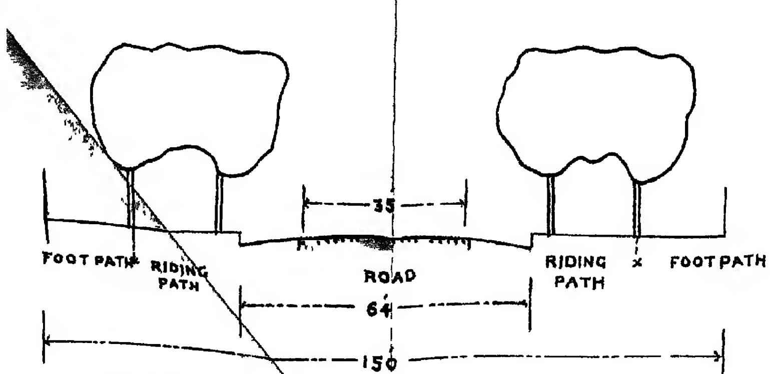
TYPICAL SECTION FOR AVENUE OF 60 FEET



TYPICAL SECTION FOR AVENUE OF 80 FEET



TYPICAL SECTION FOR AVENUE OF 240 FEET



TYPICAL SECTION FOR AVENUE OF 150 FEET

Photo-Mechl. and Litho. Dept., Thomason College, Roorkee.

DESIGNED AND DRAWN BY
MR. H. V. LANCHESTER.

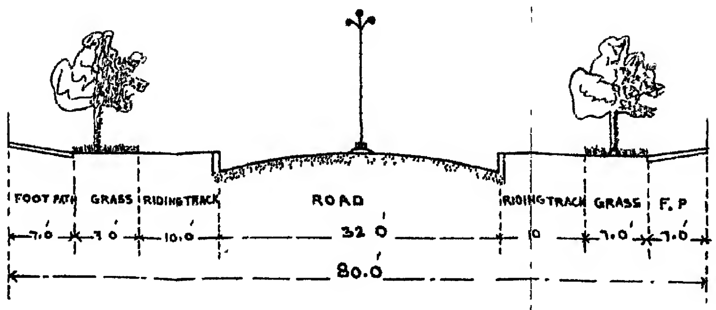
Zinco, October, 1912.—No. 9466-M.30

NEW CAPITAL DELHI

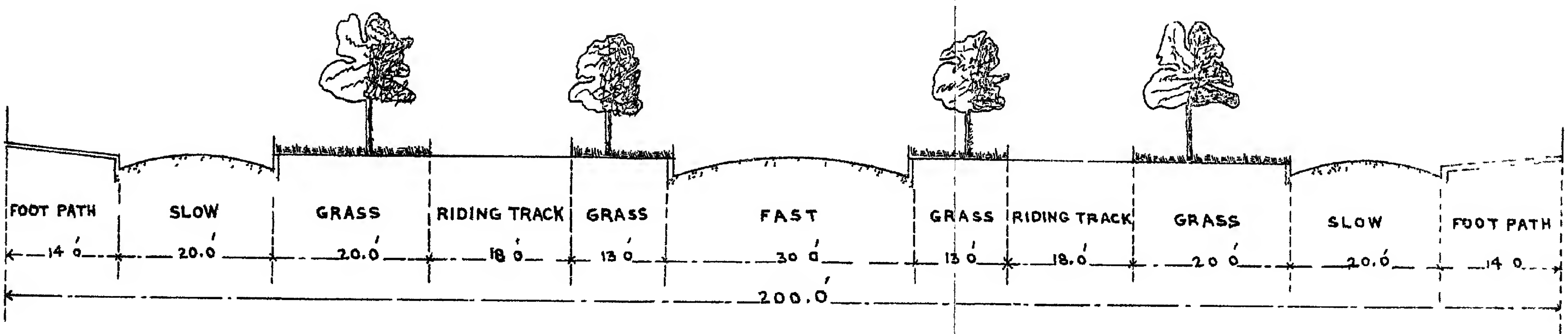
ROADS AND AVENUES

ALTERNATIVE ESTIMATE MAIN AVENUE REDUCED TO 200 FEET BROAD

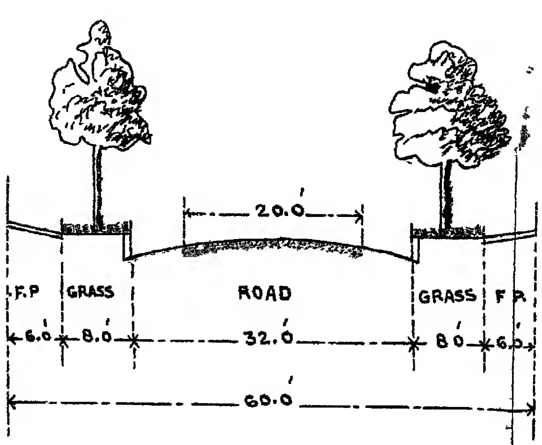
SCALE 16 FEET = 1 INCH



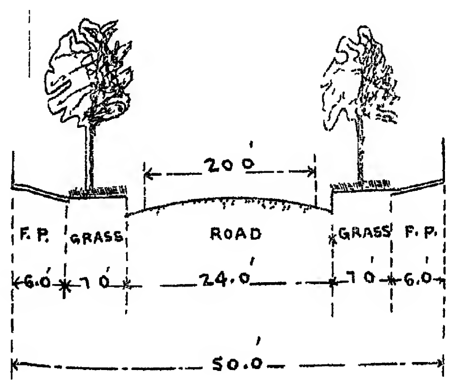
SECTION FOR AVENUE OF 80 FEET



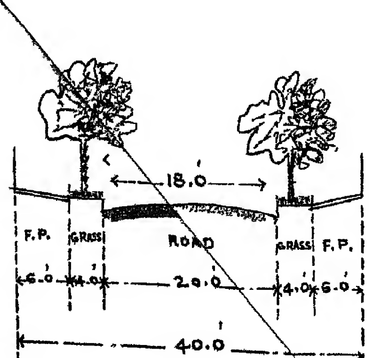
SECTION FOR AVENUE OF 200 FEET



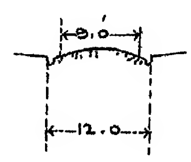
SECTION FOR ROAD OF 60 FEET



SECTION FOR ROAD OF 50 FEET



SECTION FOR ROAD OF 40 FEET



SERVICE ROAD

W. H. ROBERTS, Capt., R.E.
3rd September, 1912.

Photo.-Mechl. and Litho. Dept., Thomason College, Roorkee.

Zinco. October, 1912.—No. 9463-50

ESTIMATE No. VI.

Parks ... ... Rs. 8,38,000.

708HD

ESTIMATE NO. VI.—PARKS.

Report dated 20th September 1912 by Mr. G. F. deMontmorency, I.C.S., on the cost of parks.

LIST OF CONTENTS.

Report dated 20th September 1912, by Mr. G. F. deMontmorency, I.C.S., on the cost of parks.

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1. *Rates given by Mr. Griessen.*—Mr. Griessen sent through the Government of the United Provinces an estimate of what the Agra Park had cost to establish. Several points in the estimate were exceedingly difficult to understand and Mr. Griessen was asked to explain them. He has not yet replied, and he says he is unable at present to come to Delhi and go through them verbally. In default of getting any further explanation from him in the near future, we must average out his initial expenditure per acre as best we can. His init al expenditure per acre averages out as follows :—

	Rs.
1. Irrigation	388 per acre.
2. Preparing the ground, planting and fencing	1,028 " "
3. Roads	173 " "
4. Cost of land	not relevant for Delhi purposes.

The irrigation figure includes the construction of a minor distributary, and the establishment of dams at various points for lifting water on to high grounds. The roads include several main roads through the Agra Park in addition to paths and minor roads.

2. *Park areas.*—The park areas in the new imperial city will probably be extremely wide. In the present tentative lay out the following parks are provided for—

	Acres
The Secretariat Block Parks	129
The Secretariat Extension Parks	169
The Government House Plaza	108
Safdar Jang Park	115
Lodi Tomb Park	144
Jantar Mantar Park	21
Delhi City Park	407
Grant total ...	1,093

3. *Cost of parks using Mr. Griessen's figures.*—According to Mr. Griessen's estimates the cost of parking this area would be as follows :—

	Rs.
Irrigation	4,24,084
Preparing ground, planting and fencing	11,23,604
Roads	1,89,089
Land	1,23,509
Grand total Rs.	18,60,286

4. *Chief items in a park estimate.*—In any park the chief items must be—

1. Fencing ;
2. Roads and paths ;
3. Irrigation arrangements ;
4. Housing of establishment and cattle ;
5. Levelling ground, drainage, putting down grass, trees, shrubs and occasionally gardens.
6. Establishment during construction.

These items may be discussed separately.

5. *Fencing.*—It is a question whether fencing need be provided at all. Diversion roads round the site will lead off all animals and traffic from the country and Delhi and there will be no camels, goats or herds of cattle belonging to any one in the new city. A strong cantonment law will deal with any one who allows any animal to stray in these parks. The imperial city will consist chiefly of enclosed compounds and these open park spaces will form the variation to streets of enclosed compounds, bazars or offices. I therefore think there will be no need to fence them and that it would be preferable not to do so. I would make no estimate accordingly for the cost of fencing.

6. *Roads.*—In the present lay out all these parks are amply served and traversed by thorough fare roads. These thorough fare roads are part of the lay out of the new city, and form the communicating link between different parts of the city. They are not chargeable to the park estimate. It will be sufficient to allow Rs. 4,000 for minor paths only.

7. *Irrigation arrangements.*—General arrangements for irrigation for the whole of the new city area will be made and a share of the initial cost will be charged off towards parks according to the area occupied relatively. This forms a detail of the general irrigation estimate. The portion to be directly charged to parks, relates to the smaller distribution channels within the parks themselves. Mr. Griessen's figure is too high for a general average for this charge. In the Durbar area, on 265 acres of camp area actually irrigated, the cost of watercourse construction and maintenance worked out to Rs. 120 per acre irrigated, and on the whole area Rs. 35 only

Rs. 120 would be a fairly safe figure to adopt, as these park areas will lend themselves to more flexible treatment with each block being in the same hands for management and water distribution. The actual channels will be more elaborate and there may be more piping ; but the total cost should be very much the same. We may therefore take 1,100 acres at Rs. 120 = Rs. 1,32,000.

8. *Housing of establishment and cattle.*—The housing of the european gardeners has been provided for separately in the buildings' estimate. The housing of the indian gardeners and a few cattle has to be allowed for also a few tool and potting sheds. A good many of the cattle and menials can be provided for in the housing arragements for municipal menials and cattle for, which provision has been made in the buildings' estimates. Several parks will be in proximity to each other, so it will be sufficient to allow for a few houses for malis, tools, potting sheds and a few cattle at three centres only. Rs. 3,000 for each centre would be sufficient to allow, or Rs. 9,000 in all. It will occasionally be possible to use some old houses in situ.

9. *Levelling ground, drainage, putting down grass, trees and shrubs and occasional bits of intensive garden.*—This is an item on which it is possible to spend any amount of money, and it is difficult to estimate. A good deal of earth will have to be got out of storm water drains and most of the levelling up will be charged to the general drainage estimate, and not to the park estimate. Levelling down is hardly likely to be done in the park areas as undulations are picturesque in such localities. Mr. Griessen's figure of Rs. 1,028 per acre is high; it cost much less than this in initial expenditure to turn the Lyallpur desert into the Lyallpur public gardens. The figure there for initial expenditure was only

about Rs. 500. This was about the figure for some similar operations in extending the Lahore gardens and the Rawalpindi park. I think we may safely adopt Rs. 600 per acre as a figure. The cost of this item would then be Rs. 6,60,000.

10. *Establishment during construction.*—A liberal allowance must be made for this. Heavy establishment in the early stages does more to develope a park or garden than actual initial expenditure. 5 per cent of the figure for the item in paragraph 9 would probably suffice. This is Rs. 33,000.

11. *Total cost of parks.*—The total of the park estimates would thus be for 1,093 acres—

	Rs.
(*a*) Fencing	*Nil*
(*b*) Roads	4,000
(*c*) Irrigation channels	1,32,000
(*d*) Housing establishment and cattle	9,000
(*e*) Levelling ground, drainage, putting down grass, trees, shrubs and occasional bits of intensive garden ...	6,60,000
(*f*) Establishment during construction	33,000
Total ...	8,38,000

or about Rs. 766 per acre.

12. *Points on which instructions are required.*—Points on which instructions are required can be more easily dealt with in the general report.

13. *Schedule of rates.*—A schedule of rates used in this estimate is added for convenience in reference.

Schedule of rates used in this estimate.

Item.	Cost.	Per.
	Rs.	
1. Paths	4,000	Lump sum.
2. Irrigation arrangements	120	Acre.
3. Groups of mali residences, tool and potting sheds, etc. ...	3,000	Group.
4. Levelling ground, drainage, grass, trees, shrubs and occasional gardens	600	Acre.
5. Work charge establishment	5 per cent	on item 4.

G. C. B. P., Simla.—No. 708 H. D.—14-11-12—55—N.M.

ESTIMATE No. VII.

Buildings ... ... Rs. 2,64,90,242.

708HD

ESTIMATE NO. VII—BUILDINGS.

Report dated 3rd September 1912, by Captain W. H. Roberts, R.E., on the cost of buildings.

LIST OF CONTENTS.

List of statements.

List of plans.

Plan shewing allocation of building plots (scale 4 inches to 1 mile) in separate cover. Plan No. 1.

Report dated 3rd September by Captain W. H. Roberts, R. E., on the cost of buildings.

This estimate provides for the cost of constructing all classes of government buildings in connection with the new capital at Delhi. The data on which it is based is somewhat incomplete, but is the best that can be obtained up to date.

2. The buildings may be grouped as under:—

(*a*) Residences for officials including Government House, the residence of the Commander-in-Chief, local administrative and municipal staff.

(*b*) Clerks' quarters, both european and indian.

(*c*) Secretariat and other office buildings.

(*d*) Miscellaneous public buildings.

(*e*) Menials' quarters.

Each of these sub-heads has its own separate report and explanation as to how the numbers, sizes, rates, etc., have been arrived at.

3. In the case of rentable buildings the cost of land on which the buildings are situated, that is to say, the cost of the compounds, is included in the capital cost of each residence. This has been done as it affects the rent. But in the case of non-rentable buildings it is excluded.

4. This estimate does not include the cost of electric light fittings in the bungalows or office buildings as this item will form a separate sub-estimate, but the rates include—

(*i*) Sewage connections.

(*ii*) Drinking water connections.

(*iii*) Irrigation water connections.

5. The total cost of the buildings is as under, inclusive of the cost of land in the case of residential quarters:—

	Rs.
(*a*) Residences for officials including Government House and the residence of the Commander-in-Chief, local administrative and municipal staff ...	1,03,62,574
(*b*) Clerks' quarters, both european and indian ...	70,03,121
(*c*) Secretariat and other office buildings	86,03,030
(*d*) Miscellaneous public buildings	4,89,000
(*e*) Menials' quarters	2,69,340
Total ... Rs.	2,67,27,065
The total cost of land on which the residential quarters are situated amounts to	2,36,823
Therefore the cost of buildings alone is	2,64,90,242

These estimates are based on the attached lists of "Clerks' and menials' quarters," and the "estimate of areas required" and that for the secretariat offices from details supplied by the various departments.

6. This estimate should be considered as giving the maximum cost of the buildings. The question of the removal of several offices subordinate to

the Commerce and Industry Department and the removal of whole of the Army Head Quarters has not yet been finally decided, but this estimate provides for the removal of the whole of these offices to Delhi.

7. The estimate for residences for officers includes a married scale quarter for each officer, as has been pointed out in the report a saving of about Rs. 5,18,790 would be effected if quarters were provided on a less lavish scale, thus allowing for a certain proportion of bachelors who would not each require a house.

This would reduce the cost to Rs. 2,59,71,452 or say Rs. 2,59,50,000, but it is quite possible that the estimate may be further reduced when the question of the location of certain offices is finally settled.

8. A separate note is included on the subject of plinth area rates.

PLINTH AREA RATES.

The following notes are added in explanation of the rates entered in the various sub-estimates.

(*i*) *Secretariat blocks.*—The highest plinth area rate is taken as Rs. 15 for a two storied building, and the lowest as Rs. 10.

Several officers that have been consulted considered these rates to be reasonable. The plinth area rates for offices of the class required at Delhi that have been constructed in various parts of India vary from about Rs. 8 to Rs. 20 for two storied buildings. The large variation in these figures is due to the class of work carried out, and the difference in rates in different districts. The amount that can be spent in the first instance on these secretariats will no doubt depend largely upon the estimated cost of other items of the project. The rates here entered are however considered to be fair average ones for a good class of building.

(*ii*) *Officers' quarters.*—With the exception of the best class of residence for Members of Council, and a slightly inferior class for registrars, etc., the plinth area rate for the main buildings is taken as Rs. 3 per square foot and Rs. 1-4 for the out-houses.

These rates are somewhat in excess of those for officers' residences that have been recently constructed in the Punjab and the United Provinces, where the average rate for the main building is about Rs. 2-8 and for the out-houses Rs. 1 to Rs. 1-2. But it appears that rates are considerably higher now than they were, say, 10 years ago, also the rate of Rs. 3 includes sewage, drinking water and irrigation connections which items have not been generally included in the buildings costing Rs. 2-8 per square foot. The rate of Rs. 3 per square foot, although high, is not considered excessive.

The rate for the residences of Members of Council is taken as Rs. 5 per square foot, as owing to the status of these officials, it is considered that the interior finish of these quarters should be superior to that of others.

For the class proposed for registrars, etc., the rate has been reduced to Rs. 2-12 per square foot. This has been done for the purpose of keeping the rent of the quarter as low as possible. These residences will therefore be very slightly inferior to the others.

(*iii*) *European clerks' quarters.*—The rate for the main building of the best class of quarter is taken as Rs. 2-4 per square foot, and Rs. 2 for the other classes. The class of work will not be quite so good as that of the officers' quarters. The chief savings will be in the reduced height of the building, inferior internal finish and fittings and in an inferior class of floor. Residences of the class proposed were constructed at Lahore in 1907 at an average cost of Rs. 1-8 per square foot, but at Delhi the rates will undoubtedly be higher.

The rate for the out-houses is Rs. 1-4 as in the case of officers' quarters.

(*iv*) *Indian clerks' quarters.*—The rate for the main buildings of the better class of clerks' quarters are Rs. 2-4 and Rs. 2 per square foot as in the case of european clerks, but for clerks drawing between Rs. 100 and Rs. 200 per month, and for clerks drawing less than Rs. 100 the rates have been reduced to Rs 1-12 and Rs. 1-8 respectively. This is done with the view of keeping the rents of these classes as low as possible. The rate for out-houses is Rs. 1-4 as before.

(*v*) *Menials' quarters.*—Re. 1 per square foot for this class of quarter is proposed. Owing to the large number of quarters required all of the same pattern, and to the fact that many quarters will be contained in one block this rate is considered sufficient.

(*iv*) *General remarks.*—The rates as entered are probably on the high side, but for this preliminary estimate it is considered more desirable to err on high side than to underestimate the cost.

The rates existing at Delhi at the present time are considerably above the normal. They were probably raised at the time of the Durbar, and the construction of the temporary works in a hurry has not tended to lower them.

But for the execution of the permanent works an attempt should be made to lower the rates to at least those of the surrounding districts. This could only be done by inviting tenders for the various works from well-to-do contractors from all parts of India, and thus establish real competition. This should effectually break any ring of Delhi contractors. Good arrangements for the supply of water on the site for building and domestic purposes, conservancy arrangements, and arrangements for temporary bazaars, shelter for the workmen, etc., would also tend to lower rates.

OFFICERS' QUARTERS.

The designs for officers' quarters have been put out to open competition but for the purpose of framing a rough estimate of the cost it has been necessary to prepare certain type plans of residences to enable the approximate plinth area of each class of residence to be ascertained. This estimate is thus based on the plinth areas of these type drawings. The plinth areas of the selected designs resulting from the competition will probably be much the same as those of the designs here illustrated, although the general arrangements of the rooms and their sizes may be totally different.

2. In the Public Works Department code it is laid down that the rent of a residential quarter should represent interest on the capital cost at the rate of $3\frac{1}{2}$ per cent plus the annual cost of special and annual repairs. It is also stated that the rent to be paid by any individual should not exceed 10 per cent of his salary.

3. If it is assumed that the special and annual repairs together represent $2\frac{1}{2}$ per cent of the capital cost; the total percentage will be 6. This estimate is therefore based on a return of 6 per cent per annum to Government on the capital outlay.

4. As it is customary for Honourable Members, Secretaries to Government, and certain other senior officials to pay rent for their residences in Simla which amounts approximately to 5 per cent of their salaries for the whole year, it is obvious that the annual rental of their residences in Delhi should not exceed another 5 per cent, otherwise the total rent that these officers would be paying would exceed 10 per cent which is not only undesirable, but quite unnecessary, as comfortable and sufficiently commodious quarters can be constructed at Delhi for this class of officer having a rental varying from 3·1 to 4·8 per cent of the occupants salary. The percentages of rent to salary for the various classes of quarters proposed is shown in column 10 statement D. It will be noticed that the percentage is generally lower for the better class of residence than it is for the smaller ones. The highest percentage occurs in the case of a F(*ii*) class quarter. For this class of quarter it is as high as 9·6 for an officer whose salary is Rs. 800 per month, but it is reduced to 6·4 for an officer

on Rs. 1,200 per month. Generally speaking the lower paid officials do not have to spend 5 per cent of their salaries on the rent of houses in Simla as many of them live in hotels and flats. It would be very difficult, if not impossible, to design a suitable quarter for a junior officer on say Rs. 800 or Rs. 900 per month having its rent not exceeding Rs. 40 or 45 per month (*i.e.*, 5 per cent of the salary).

5. Six different classes of quarters are proposed, namely C. D. E. F(*i*), F(*ii*) and G. Details are as under:—

Class C.—This is the best type of residence proposed, and is suitable for occupation by a Member of Council.

The accommodation proposed allows for a large dining room, drawing room and hall, a library or study, and four bed rooms with two dressing rooms. The out-houses will consist of 14 servants quarters, 4 stalls, 3 godowns, a coach house and a motor shed, and a kitchen with two store rooms attached. The plinth area rate for the main building is taken as Rs. 5 per square foot as against Rs. 3 for all other residences, so the fittings and internal finish of this class of residence will be superior to that of any other class.

Class D.—This type is proposed for the members of the Railway Board and secretaries to Government, and any other officers whose pay is between Rs. 5,000 and Rs. 3,200 per month. The accommodation provided is much the same as that for class C, but the rooms in the main building are some what smaller, the out-house accommodation is exactly the same as that allowed for class C.

Class E.—This class of quarter is proposed for additional and deputy secretaries, generals and colonels and any officer whose pay lies between Rs. 3,000 and Rs. 1,600 per month. The drawing and dining rooms are smaller than those of class D, as is also the hall, but 4 bed rooms are provided. The out-houses consist of 12 servants quarters, 3 stalls and a coach house. The cook house block which contains the store rooms is attached to the main building by a covered passage.

Class F(i).—This class of quarter is proposed for assistant and under secretaries whose pay varies from Rs. 1,600 to Rs. 1,300 per month. The accommodation consists of a dining room, drawing room, hall, 3 bed rooms with 2 dressing rooms. The out-houses consist of 8 servants quarters, 2 stalls and 1 coach house. The cook house block which contains the store rooms is attached to the main building by a covered passage.

Class F(ii).—This class of quarter is intended for occupation by junior officers whose salary lies between Rs. 1,200 and Rs. 800 per month. The accommodation in the main building is the same as that for class F(*i*), but the rooms are somewhat smaller. The out-houses consist of 6 servants quarters, 2 stalls and 1 coach house The cook house block is much the same as that for class F(*i*).

Class G.—This class of quarter is intended for registrars, chief clerks, personal assistants and other officers whose pay is about Rs. 800 per month. The accommodation in the main building is very slightly smaller than that of class F(*ii*), but the out-houses consist of only 5 servants quarters, 1 stall and 1 coach house.

The cook house block is similar to that of class F(*ii*). The capital cost of this class of quarter is somewhat less than that of class F(*ii*) as the plinth area rate is taken as Rs 2-12 instead of Rs. 3, as it is considered that the finish of this class of quarter can be somewhat inferior to that of the other classes, even as it is the percentage of rent to pay for this class is rather high, being 8·3.

6. These quarters are all suitable for occupation by married men, and no separate provision has been made for bachelor officers. The great majority of the senior officers who would occupy class C, D and E are married, and the officers who would occupy class G are usually married men. It is therefore recommended that quarters for these officers should be entirely provided

for on a married scale. The majority of bachelor officers will be found to be among those who would occupy class F(*i*) and F(*ii*). It is therefore open to question whether or not a quarter on a married scale should be provided for each officer that belongs to these classes. The unit system of bachelor quarters as adopted in the army is not altogether suitable in the case of civil officers. For military officers it is usual to construct blocks containing say 4 bachelor quarters each in the vicinity of the officers' mess. The officers can thus use the mess for all their meals. In the case of civil officers there is usually no place to correspond to an officers' mess, unless it is the local club, and it might be inconvenient for the quarters to be located near by, or even if they were, the club might not be able to cater for officers living outside the club premises. Many bachelor officers will probably be accommodated in club quarters, and it is suggested that other bachelors should occupy the married quarters—two bachelors being accommodated in each. This estimate provides for a married quarter for each officer, *i.e.*, 36 quarters of class F(*i*) and 97 of class F(*ii*). In the first instance it will probably be sufficient if three quarters of these amounts are constructed, namely 27 of class F(*i*) and 73 of class F(*ii*), this would mean a saving of Rs. 5,18,790.

7. Statement H is an abstract of the total cost of all residential quarters including the probable cost of Government House and staff quarters, also the cost of the Commander-in-Chief's residence and his staff. The cost of the Commander-in-Chief's residence is taken as being double that of a residence for a Member of Council.

8. Statement J is a list of officers who may possibly be located at Delhi regarding whom no decision has been arrived at up to the present. They are not included in the total estimate of cost.

9. It should be noted that in each case the capital cost of a residence includes the cost of the compound in which it will be situated.

STATEMENT D.

OFFICERS' QUARTERS.

Statement showing the class of quarters proposed for each grade of official, and statement of the cost and rent of each residence.

Class.	Grade of officer for whom the quarter is proposed.	Number of officers of each class.	Average monthly pay of officer.	Maximum permissible rent	Cost of Residence: Building.	Cost of Residence: Cost of land at Rs. 113 per acre.	Cost of Residence: Total.	Rent per month based on a return of 6 per cent	Rent (column 9) shown as a percentage of pay.	Remarks.
1	2	3	4	5	6	7	8	9	10	11
			Rs.		Rs.	Rs	Rs.			
C (i)	Members of Council	6	6,667	666·7	57,000	678	57,678	288·4	4·3	
C (ii)	Railway Board and Bishop	4	5,000	500	30,500	565	31,065	155 3	3 1	A D (i) residence is proposed for these officers.
			3,330	333	30,500	565	31,065	155·3	4·6	
D (i)	Secretaries, generals and other officers whose pay lies between Rs. 3,200 and Rs. 4,500.	13	4,500	450	30,500	565	31,065	155·3	3 4	
			3,200	320	30,500	565	31,065	155 3	4 8	
D (ii)	Officers whose salary lies between Rs. 2,000 and Rs. 3,000 inclusive.	22	3,000	300	22,500	565	23,065	115·3	3 8	An E residence is proposed for these officers.
			2,000	200	22,500	565	23,065	115 3	5 7	
E	Additional and deputy secretaries and colonels, etc.	43	2,500	250	22,500	452	22,952	114·7	4·6	
			1,600	160	22,500	452	22,952	114·7	7 2	
F (i)	Under secretaries	36	1,600	160	17,710	339	18,049	90 2	5·6	
			1,300	130	17,710	339	18,049	90 2	6·9	
F (ii)	Majors, captains and all officers drawing between Rs. 1,200 and Rs. 800 per month.	97	1,200	120	14,975	339	15,314	76 5	6 4	
			800	80	14,975	339	15,314	76 5	9·6	
G	Registrars, chief clerks, personal assistants, etc. ...	29	800	80	13,100	198	13,298	66·5	8 3	This class includes all officers who are entitled to a compound area of $1\frac{3}{4}$ acres.

NOTE.—Classes C (ii) and D (ii) are the same as classes D and E. The letters are used to correspond to those in the "estimate of areas required." The number of officers of each class is taken from the detailed lists which are printed separately.

STATEMENT E.

Estimate of cost of the residential quarters required by the Commander-in-Chief and his staff.

Residence.	Class of quarter proposed	Cost of residence.	Cost of land at Rs 113 per acre	Total cost
	Rs	Rs	Rs	Rs.
Commander-in-Chief	...	*1,14,000	4,011	1,18,011
Military Secretary ...	Class E	22,500	678	23,178
Assistant Military Secretary ...	Class F (ii)	14,975	395	15,375
Surgeon	Class F (i)	17,710	565	18,275
4 Aides-de-Camp	..	22,000	1,356	23,356
1 Indian Aide-de-Camp	Class B (Clerks quarters.)	4,443	169	4,612
Total cost ...	...	1,95,628	7,174	2,02,802

* The cost is assumed as being double that of a residence for a Member of Council.

STATEMENT F

Administrative and municipal residences.

Designation of official.	Class of quarter proposed	Cost: Of building.	Cost: Of land at Rs. 113 per acre.	Total cost.	REMARKS.
		Rs.	Rs.	Rs.	
Commissioner of the Enclave .	D (i)	30,500	678	31,178	
Special Officer for the Administration of Delhi	E	22,500	452	22,952	
Personal Assistant to Commissioner.	F (i)	17,710	339	18,049	
Engineer officers	F (i)	17,710	452	18,162	
	F (ii)	2×14,975	2×452	30,854	
Sanitary officer	F (ii)	14,975	452	15,427	
Civil-surgeon	F (i)	17,710	452	18,162	
Police officer	F (i)	17,710	452	18,162	
2 Inspectors of police ...	B	2×6,384	2×169	13,106	European clerks scale.
3 Head clerks	B	3×6,384	3×169	19,659	Ditto.
1 Assistant surgeon ...	B	4,443	169	4,612	Indian clerks scale.
1 School inspector ...	A	8,302	339	8,641	European clerks scale.
Total ...	...	2,13,430	5,534	2,18,964	

STATEMENT G.

Miscellaneous list.

Designation of official.	Class of quarter proposed.	Cost: Of building	Cost: Of land at Rs. 113 per acre.	Total cost.	REMARKS.
		Rs.	Rs.	Rs	
2 European gardeners ...	C	2×4,542	2×226	9,536	European clerks scale
1 Bishop's chaplain ...	F (ii)	14,975	339	15,314	Officers' scale.
Total ...	...	24,059	791	24,850	

STATEMENT H.

Probable cost of Government House, the Commander-in-Chief's residence, and residences for all officers.

Name or class.	Number of quarters.	Cost of each residence		Total cost.		Remarks.
		Building	Land.	Building.	Land.	
		Rs.	Rs.	Rs.	Rs	
Government House	...	50,00,000	26,555	50,00,000	26,555	Includes cost of quarters for the staff.
Commander-in-Chief's residence and quarters for staff ...	...	...	...	1,95,628	7,174	See Statement E.
Class C (*i*)	6	57,000	678	3,42,000	4,068	
Class C (*ii*)	4	30,500	565	1,22,000	2,260	
Class D (*i*)	13	30,500	565	3,96,500	7,345	
Class D (*ii*)	22	22,500	565	4,95,000	12,430	
Class E	43	22,500	452	9,67,500	19,436	
Class F (*i*)	36	17,710	339	6,37,560	12,204	
Class F (*ii*)	97	14,975	339	14,52,575	32,883	
Class G	29	13,100	197	3,79,900	5,742	
Administrative and municipal residences	...	...	...	2,13,430	5,534	See Statement G.
Miscellaneous list	...	...	...	24,059	791	See Statement F
Total ...	...	...	...	1,02,26,152	1,36,422	Total for residences and land Rs. 1,03,62,574

NOTE.—The number of officers of each class is taken from the detailed lists which are printed separately.

STATEMENT J.

List of officers for whom accommodation may possibly be required at Delhi.

Designation of official	Class of quarter proposed	Cost: Of building	Cost: Of land at Rs. 113 per acre	Total cost	REMARKS.
		Rs.	Rs	Rs	
Archdeacon	E	22,500	565	23,065	
Director of Geological Survey	E	22,500	452	22,952	
Director-General of Commercial Intelligence	E	22,500	452	22,952	
Controller of Printing and Stationery.	E	22,500	452	22,952	
Controller of Patents ...	F(i)	17,710	339	18,049	
5 Officers, Geological Survey.	F(ii)	2 × 14,975	2 × 339	33,628	
	G	3 × 13,100	3 × 339	40,317	
Librarian, Imperial Library	F(ii)	14,975	339	15,314	
Special duty officer, Military Finance.	F(ii)	14,975	339	15,314	
Deputy Controller of Printing and Stationery.	G	13,100	198	13,298	
Assistant Controller of Printing and Stationery.	B	6,384	198	6,582	European clerks scale.
6 Press officers	B	6 × 6,384	6 × 198	39,492	Ditto.
Total ..	...	2,64,698	6,217	2,70,915	

CLERKS' QUARTERS.

The attached statement shows in detail the probable number of clerks for whom provision must be made in the new capital. The figures are liable to subsequent modification as the question of the removal of the whole of Army Head Quarters, and certain subordinate offices to the Commerce and Industry Department has not yet been decided. The statement however includes the whole of establishment of these offices, so should the statement be modified, it will probably take the form of a reduction and not an increase, consequently this estimate may be considered as a maximum approximation of the cost of providing accommodation for all classes of clerks.

2. In the Public Works Department code it is laid down that the rent of a residential quarter should represent interest on the capital cost at the rate of $3\frac{1}{2}$ per cent *plus* the annual cost of special and annual repairs. It is also stated that the rent to be paid by any individual should not exceed 10 per cent of his salary.

3. If we assume that the special and annual repairs together represent $2\frac{1}{2}$ per cent of the capital cost, we have a total percentage of 6. This estimate is therefore based generally on a return of 6 per cent on the total capital cost. In a few cases only as subsequently explained will the return be less than this amount.

4. In drawing up a scale of accommodation these figures have been borne in mind and Statements B and C, show that with the rent of each quarter based on a return to Government of 6 per cent of the capital outlay, it is in most cases well below the maximum, permissible rental of 10 per cent of the occupant's salary, but in the lowest scale of accommodation, the rents proposed usually exceed the limit of 10 per cent, this is owing to the difficulty of designing suitable accommodation for low paid clerks based on their pay. For example, it seems impossible to design a suitable quarter for a married european drawing say only Rs. 90 per month, and yet keep the rent down to Rs. 9 or under. In the design proposed for this grade of clerk the rent represents 19 per cent of the occupant's pay, but the number of clerks in this grade is small, so the loss to Government would not be much.

European clerks' quarters

5. Four different classes of quarters are proposed.

Class A—(for Superintendents on Rs. 500 per month)—contains—

1 drawing room 16′ × 18′.

1 dining room 16′ × 18′.

1 bed room 16′ × 18′.

1 bed room 16′ × 16′.

1 office or bed room 16′ × 12′.

4 servants' quarters and a cook house.

Class B—(for clerks on Rs. 301 to Rs. 500) contains—

1 sitting room.
1 dining room.
1 bed room 16′ × 18′.
1 dressing room 10′ × 16′.
1 bed room 12′ × 16′.
3 servants' quarters and a cook house.

Class C—(for clerks on Rs. 201 to Rs. 300) contains—

1 combined sitting and dining room.
2 bed rooms, each 16′ × 14′.
3 servants' quarters and a cook house.

Class D— (for clerks on Rs. 100 to Rs. 200 and also below Rs. 100) contains—

1 combined sitting and dining room 19′ × 14′.

2 bed rooms, each 14′ × 14′.

2 servants' quarters and a cook house.

6. The attached drawings show in detail the arrangement of the various rooms. These quarters are all suitable for occupation by married men. It is not proposed to have separate designs for bachelor quarters, but two bachelors can be accommodated in one quarter of the class to which they belong. The clerks themselves would probably prefer this arrangement as being more comfortable for them than unit quarters containing several clerks.

7. Statement B shows the cost of each proposed class of quarter and the percentage of rent to the occupant's pay. In class A the percentage is 8·4 but in class B and C, the maximum percentages for clerks drawing Rs. 301 and Rs. 201 are 10·7 and 11·5 per cent respectively, but for clerks drawing Rs. 500 and Rs. 300 which is the maximum pay of clerks occupying B and C class quarters the percentages are only 6·5 and 7·7, respectively.

8. As regards class D it appears impossible as explained above to keep the percentage of rent to pay below 10. For the accommodation proposed the percentage is 9·6 for a clerk drawing Rs. 200 per month, for clerks drawing less than Rs. 200 the percentage is above 10, but this class is proposed for all clerks drawing less than Rs. 200. As already pointed out the loss to Government will not be great as there are not many married europeans drawing less than Rs. 100. Where two bachelors occupy a quarter the full rental of the bungalow will in almost every case be collected.

Indian clerks' quarters.

9. For Indian clerks five types of quarters are proposed.

Class A—(for Superintendents on Rs. 500 per month) contains—

6 living rooms.

2 bath rooms.

2 store rooms.

1 cook house.

3 servants' quarters.

Class B—(for clerks on Rs. 301 to Rs. 500 per month) contains—

5 living rooms.

2 bath rooms.

2 store rooms.

1 cook house.

2 servants' quarters.

Class C—(for clerks on Rs. 201 to Rs. 300 per month) contains—

3 living rooms.

1 bath room.

1 store room.

1 cook house.

2 servants' quarters.

Class D—(for clerks on Rs. 100 to Rs. 200) contains—

2 living rooms.

1 bath room.

1 store room.

1 cook house.

1 servant's quarter

Class E—(for clerks drawing less than Rs. 100 per month) contains—

2 living rooms (smaller than in class D).

1 bath room.

1 store room

1 cook house.

1 servant's quarter.

10. The attached drawings show in detail the arrangement and sizes of the various rooms.

11. As the great majority of indian clerks are either married, or else have their families living with them, all the quarters are provided on a married scale basis. No bachelor quarters at all are proposed for indian clerks.

12. In the case of indian clerks the percentage of rent to salary works out generally less than that in the case of the european clerks, the explanation of this is that it is possible to design a suitable quarter for an indian at a less cost than for an european on the same salary. Statement C shows the cost of each quarter proposed and the percentage of rent to salary for each class.

13. For classes A, B and C the percentage varies between 5·6 and 8·5, but in class D the maximum percentage is 11 2 for a clerk on Rs. 100 and 5 6 for a clerk on Rs. 200. Only in a few cases would the percentage exceed 10 as for a clerk on Rs. 120 per month it would be 9 5.

14. For class E the percentage is high, namely 9·7 but for this class it is difficult to design suitable accommodation for less than about Rs. 1,558, but an economy will undoubtedly be effected by constructing several quarters in one block and this should somewhat lower the percentage.

15. Statement A is an abstract of the cost of construction of quarters for all the clerks both european and indian. This estimate includes the cost of the land taken up in compounds. The total cost amounts to Rs. 69,69,377.

STATEMENT A.

CLERKS' QUARTERS.

Abstract Estimate of cost.

Class.	Designation of clerk.	Pay per month.	Number of quarters.	Cost of each — Residence.	Cost of each — Land.	Total cost of each — Residence.	Total cost of each — Land.	Remarks.
	European clerks.	Rs.		Rs.	Rs.	Rs	Rs.	
A	Superintendents	500	55	8,302	141	4,89,818	8,319	
A	Do.	500	4	8,304	141			
B	Clerks	301 to 500	85	6,384	113	6,12,864	10,848	
B	Do.	Do.	11	6,384	113			
C	Clerks	201 to 300	117	4,542	85	6,31,338	11,815	
C	Do.	Do.	22	4 542	85			
D	Clerks	100 to 200	116	3,818	56	6,91,058	10,136	
D	Do.	Do.	65	3,818	56			
D	Clerks	Under Rs. 100	20	3,818	11 3	1,33,630	396	
D	Clerks	Do.	15	3,818	11·3			
	Total for european clerks ...	...	...	.	...	25,58,708	41,514	
	Total for residences and land ...	...	..	...	...	..	...	Rs. 26,00,222
	Indian clerks.							
A	Superintendents	500	13	6,622	141	86,086	1,833	
B	Clerks	301 to 500	38	4,443	113	1,68,834	4,294	
C	Do.	201 to 300	77	3,322	85	2,55,794	6,545	
D	Do.	100 to 200	456	2,198	56	10,02,288	25,536	
E	Do.	Under Rs 100	1,830	1,547	11 3	28,31,010	20,679	
	Total for indian clerks ...	...	...	...	..	43,44,012	58,887	
	Total for residences and land ...	...	...	...	...	...	...	Rs 44,02,899
	Grand total Rs.	...	...	...	...	69,02,720	1,00,401	
	Grand totals for residences and land ...	...	...	...	...	...	...	Rs. 70,03,121

NOTE.—The number of clerks of each class is taken from the detailed lists which are printed separately.

STATEMENT B.

European Clerks' Quarters.

Statement showing the cost and rent of proposed residences.

Class.	Designation of clerk.	Monthly pay.	Maximum rent that can be paid (10 per cent of salary).	Details of proposed residences. Main building: Plinth area.	Main building: Plinth area rate	Main building: Cost	Out houses: Plinth area.	Out houses: Plinth area rate.	Out houses: Cost.	Total cost of building	Cost of land at 113 per acre.	Total cost	Monthly rent based on a return of 6 per cent.	Precentage of rent to pay.	Remarks.
		Rs	Rs.	Sq. ft.	Rs.	Rs.	Sq. ft	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.		
A.	Superintendents	500	50	3230	2-4	7,267	828	1-4	1,035	8,302	141	8,443	42·2	8·4	
B.	Assistants and clerks ...	301 to 500	30 to 50	2765	2	5,530	683	1-4	854	6,384	113	6,497	32·49	10·7 to 6·5	
C.	„ „	201 to 300	20 to 30	1844	2	3,688	683	1-4	854	4,542	85	4,627	23·13	11·5 to 7·7	
D.	Clerks	100 to 200	10 to 20	1614	2	3,228	472	1-4	590	3,818	56	3,874	19·37	19·3 to 9·6	
D.	Clerks	Under 100	Average say 90	1614	2	3,228	472	1-4	590	3,818	11	3,829	19·14	21·2	

INDIAN CLERKS' QUARTERS.

Statement showing the cost and rent of proposed residences.

Class.	Designation of clerk.	Monthly Pay.	Maximun rent that can be paid (10 per cent of pay)	DETAILS OF PROPOSED RESIDENCES. Main building. Plinth area.	DETAILS OF PROPOSED RESIDENCES. Main building. Plinth area. rate	DETAILS OF PROPOSED RESIDENCES. Main building. Cost.	DETAILS OF PROPOSED RESIDENCES. Out houses Plinth area	DETAILS OF PROPOSED RESIDENCES. Out houses Plinth area. rate	DETAILS OF PROPOSED RESIDENCES. Out houses Cost.	DETAILS OF PROPOSED RESIDENCES. Total cost of building.	Cost of land at 113 per acre.	Total cost	Monthly rent based on a return of 6 per cent on capital cost	Percentage of rent to pay.	Remarks.
		Rs.	Rs.	Sq ft.	Rs	Rs.	Sq ft	Rs.	Rs	Rs.	Rs.	Rs	Rs A	Rs.	
A	Superintendents	500	50	2439	2-4	5,487	908	1-4	1,135	6,622	141	6,763	33 13	6 7	
B.	Assistants and clerks ...	301 to 500	30 to 50	1787	2	3,574	625	1-4	869	4,413	113	4,556	22 13	7 6 to 4 4	
C.	Assistants and clerks ...	201 to 300	20 to 30	1295	2	2,580	594	1-4	742	3,322	857	3,407	17 0	8·5 to 5 6	
D.	Clerks	100 to 200	10 to 20	1027	1-12	1,797	321	1-4	401	2,198	56	2,254	11 4	11 2 to 5 6	
E	Clerks	Under 100	Average say 80	842	1-8	1,263	227	1-4	284	1,547	11	1,558	7 79	9 7	

SECRETARIAT AND OTHER OFFICES.

The attached statement L. shows the probable floor areas of each building, the plinth area of the building on the assumption that the building will be two stories high, the plinth area rate and the total cost.

2. The nett floor areas as given in column 3 of the statement are arrived at from detailed schedules of accommodation, and may be taken as correct. The floor areas that are shown in column 2 have also been prepared from detailed lists of accommodation, but the figures are liable to alteration as the eventual location of several subordinate offices has not yet been definitely decided. This is particularly the case in the Commerce and Industry Department, the location of several subordinate offices not having yet been decided upon. Another case in point is that of the office of the Director-General of Posts and Telegraphs Up to date the Director-General has not been able to prepare a detailed schedule of the accommodation required by his office.

3 The accommodation allowed for the Army Department Secretariat and the branches of Army Head Quarters is sufficient for the whole of the Head Quarters It is understood that the question of the removal of the whole of the Army Head Quarters is still under consideration, but this estimate provides for the accommodation of the whole, and the estimates for officers and clerks also allow for the full staff.

4. A lump sum of only Rs. 50,000 has been entered for the Stationery and Printing offices as it is possible that these offices may not be transferred from Calcutta for many years. It has been decided that the stationery offices will at any rate not be moved during the next 5 years and the question of the removal of the press will no doubt depend largely upon the eventual disposal of the press buildings that have been constructed as a part of the temporary works at Delhi.

5. The plinth area of a two storied building is taken as being the same as the nett floor areas of the rooms in the building, exclusive of corridor, verandahs, staircases, etc. To arrive at the cost of the various blocks a plinth area rate of Rs. 15 per square foot for a two storied building is assumed for the more important blocks, and Rs. 10 per square foot for buildings that will probably not be situated in such prominent positions as those based on the Rs. 15 rate.

6. The rate of Rs. 15 for a two storied building, or say Rs. 7—8 for a single storey building would appear to be a good average rate for first class work of the nature required as carried out in the Punjab and the United Provinces. The lower rate of Rs 10 will of course not allow for such ornate structures as the higher rate, but is considered sufficient for a plainer class of building.

7. According to this estimate the cost of the secretariats and other office buildings will amount to Rs. 86,03,030.

STATEMENT L.

Showing the probable cost of secretariats and other offices.

Name of secretariat or office.	Nett floor areas. Probable amount	Nett floor areas. According to detailed schedules.	Plinth areas of buildings 2 storied.	Plinth area rate per square foot for a 2 storied building	Total cost.	Remarks.
1	2	3	4	5	6	7
	Sq feet.	Sq feet.	Sq. feet.	Rs	Rs	
Home and Legislative Department	...	49,228	49,228	15	7,[illegible]8,420	
Revenue and Agriculture and Public Works Departments	...	37,270	37,270	15	5,59,050	
Finance and Education Departments	...	65,704	65,704	15	9,85 560	
Foreign Office	...	37,000	37,000	15	5,55,000	
Commerce and Industry Department	70,000	...	70,000	15	10,50,000	
(a) Railway Department	...	30,000	30,000	10	3,00,000	
(b) Office of Commissioner of Northern India Salt Revenue	7,000	...	7,000	10	70,000	
Surveyor General's Office	74,000	...	74,000	10	7,40,000	
Photo-Litho. Office	80,000	...	80,000	10	8,00,000	
Mathematical Instrument office	41,000	...	41,000	10	4,10,000	
Post and Telegraph Secretariat	40,000	...	40,000	10	4,00,000	
Military Offices	1,03,000	...	1,03,000	15	15,45,000	For camp offices only the cost would be reduced to Rs. 11,85,000
Post and Telegraph Accounts	40,000	...	40,000	10	4,00,000	
Stationery and Press Office	...	...	...	...	50,000	Lump sum that will probably be expended in the near future.
Total ...	...	...	...	...	Rs. 86,03,030	

MISCELLANEOUS PUBLIC BUILDINGS

The attached statement K is a rough estimate of the probable cost of constructing public buildings, other than secretariats and rentable buildings, in Delhi. The figures are of necessity only a very rough approximation. The letters under which the various items are grouped correspond to those in the "estimate of area required"

2. In explanation of the statement of cost the following remarks are added:—

(1) *Town Hall*—The town hall will include the office of the enclave and the new city administration, also the Public Works Office, Office of sanitary engineer, etc The cost of the building should in the first instance not exceed Rs. 1,30,000.

(2) *Medical schools and civil hospitals.*—In the first instance the initial expenditure need not exceed Rs 50,000. For the next few years probably a small civil hospital will suffice. The question of medical schools will probably be considered later, and will not form a charge against this estimate. The cost of the medical staff is not included in this sum of Rs. 50,000 which will be available for the construction of a hospital.

(3) *Veterinary hospital.*—This is not an expensive item—Rs. 14,000 should be ample.

(4) *Post and Telegraph offices.*—Rs. 50,000 should be ample for a large combined Post and Telegraph Office.

(5) *Central police and fire station.*—Rs. 20,000 should be sufficient for a suitable building.

(6) *Sub-post and sub-police stations.*—Two small buildings are proposed, cost of each will be about Rs. 2,500.

(7) *Vegetable markets and meat markets.* In the first instance an expenditure of Rs. 10,000 should suffice, but as the city increases in size, it will probably be necessary to enlarge the buildings first erected, but this extra expenditure would not be a charge against this estimate.

(8) *Dairy.*—Rs. 60,000 is allowed for this item. This amount should cover the cost of residential quarters for the dairy staff.

(9) *Quarters for municipal cattle and horses.*—Rs. 5,000 is allowed for this item.

(10) *Quarters for municipal menials.*—The number of municipal sweepers, cattle men, chowkidars, water supply men, etc., will probably be between 75 or 100. Rs. 15,000 is allowed for.

(11) *Schools.*—Rs. 10,000 is provided for initial expenditure on schools for european and indian children. Any further expenditure under this head would probably not be debitable to this estimate.

(12) *Cemeteries.*—Rs. 2,000 should suffice for an initial expenditure.

(13) *Slaughter house.*—Rs. 3,000 will be sufficient.

(14) *Municipal minor officials.*—The number of officials is not yet known. Rs. 20,000 is given as an approximation of the cost.

(15) *Cathedral and other churches.*—It is understood that in the case of ecclesiastical buildings it is customary for Government to give a grant equal to the amount collected by private subscriptions. It is thought that the grant-in-aid in this case of the Cathedral would amount to about Rs. 80,000, and for other churches about Rs. 15,000.

3. No provision has been made in this estimate for a university, two colleges and a high school, nor for an oriental research Institute and museum as it will probably be many years before these works are undertaken. Expenditure on these items does not appear to be a legitimate charge against this estimate.

4. The total expenditure under this head amounts to Rs. 4,89,000.

STATEMENT K.

Probable cost of miscellaneous public buildings.

Name of building.	Cost.	Remarks.
P.	Rs.	
Town Hall	1,30,000	
Medical schools and civil hospitals ...	50,000	Initial expenditure only.
Post and Telegraph offices	50,000	
Veterinary hospitals	14,000	
Central police and fire station	20,000	
Sub-post and sub-police stations ...	5,000	
Vegetable market and meat market ...	10,000	Initial expenditure only.
Dairy	60,000	
Quarters for municipal menials	15,000	
Quarters for municipal cattle and horses ...	5,000	
Schools	10,000	Initial expenditure only.
Cemeteries	2,000	Initial expenditure only.
Slaughter house	3,000	
Municipal administrative, health and engineering department minor officials.	20,000	
Q.		
Cathedral	80,000	Grant-in-aid.
G(iii).		
Roman catholic church	15,000	Grant-in-aid.
Presbyterian church		
Wesleyan chapel		
Total ...	4,89,000	

MENIALS' QUARTERS.

Under the heading of menials are included duftris, peons, farashes, sweepers, etc. The total number according to the statement of clerks and menials' quarters is 1,943, but as a considerable number of these men must of necessity be accommodated on the premises of the office building to which they belong it will be sufficient to estimate for 1,800 men.

2. Each quarter will consist of one room 10' by 10' internal dimensions with a courtyard also about 10 feet square in front.

3. The length of a block containing 30 quarters would be 332 feet, and the width (neglecting the courtyard) 13 feet, so the plinth area for such a block would be ($332\frac{1}{2} \times 13\frac{1}{2}$) square feet = 4,489 square feet. 60 blocks of this size would be required so the total cost would be at a rate of Re. 1 per square foot Rs. ($4,489 \times 60 \times 1$) = Rs. 2,69,340.

4. Owing to the large number of quarters, all of the same type, to be constructed it is thought that a rate of Re. 1 per square foot will be sufficient, although Rs. 1·4 is allowed in the case of servants' quarters attached to residential bungalows.

APPENDIX A.

Summary of points on which Government of India orders are required.

The orders of the Government of India will be required on the following points before the preparation of a detailed project. Most of these points are already dealt with in the reports of the estimate to which they refer, but are here enumerated for easy reference.

(*a*) *Officers' quarters.*—(1) The designs for officers' quarters are already out to open competition. When the designs have been finally approved the question of the capital cost, and the rent of each class as compared with the average pay of the officials who will occupy each class, will no doubt be considered, but a general ruling on the subject would be of much advantage. For example many officials at present pay 5 per cent of their salaries for residences in Simla, so the rent of their houses in Delhi should not exceed another 5 per cent unless the limit of 10 per cent as laid down in the Public Works code is to be exceeded.

(2) The total number of quarters to be provided needs consideration—a married scale quarter will probably be considered necessary for each senior official whether married or not. But for officers drawing a salary of say Rs. 1,000 and under per month, it will probably be only necessary to build quarters for a certain percentage of the number of officials, as two or more bachelor officers will be found to occupy one bungalow, and others may prefer to live in hotels and clubs. Definite orders on this subject are therefore absolutely essential foi the preparation of a detailed estimate.

(*b*) *Clerks' quarters.*—The same points as mentioned above refer in an equal degree to the case of clerks' quarters. The designs are not, however, out to competition, so the scale of accommodation for each class of clerk both european and indian should be decided. This estimate provides for a married scale quarter for each indian clerk. This may, however, be considered extravagant. In the case of european clerks provision for bachelors has been allowed for on the assumption that two bachelors will occupy one married scale quarter of the class to which they belong.

(*c*) *Peons' quarters.*—The scale of accommodation should be decided. This estimate provides for each peon one room 10 feet by 10 feet with an open courtyard also 10 feet square.

(*d*) *Secretariat and other offices.*—It is very desirable that the Government of India should give some indication as to the approximate plinth area rates of the secretariat and other important office buildings. The estimate is based on Rs. 15 per square foot for the better class of buildings, and Rs 10 for other buildings. Both classes being taken as two stories high. The total estimated cost of the new capital will no doubt to a certain extent influence the decision that may be arrived at.

(*e*) *Miscellaneous public buildings.*—The total estimated amount under this head is Rs. 4,89,000. The provision made under the various sub-heads is necessarily open to much criticism. But it is essential that some provision should be made in the form of lump sum estimates.

2. The amount of office and residential accommodation that is required by several departments has not yet been finally decided. It is of course quite impossible to prepare a correct estimate of cost until the accommodation required at the new capital is definitely settled. In this connection the following points are brought to notice.

(*a*) *Army Head Quarters.*—It is not definitely decided that the whole of Army Head Quarters will move to Delhi, but this estimate provides for the cost of the removal of the whole. It is possible that in the near future only a camp office will be located at Delhi, of the same strength as that of the camp office that has been located at Calcutta during the winters of the last few years. If this be the case, it may be desirable to provide space for future expansions, and include in the estimate only the cost of accommodation for a camp office.

(*b*) *Offices under the control of the Surveyor General*—The question of the location of the office of the Surveyor General, the Photo-Litho office and the Mathematical Instrument office has not yet been decided—but provision for these offices has been made in the estimate.

The cost of the office buildings alone is as under :—

	Rs
Surveyor General's Office	7,40,000
Photo-Litho Office	8,00,000
Mathematical Instrument Office	4,10,000

(*c*) *Commerce and Industry Department.*—The location of the following offices subordinate to the Commerce and Industry Department has not yet been settled—

(*a*) Office of the Director General of Commercial Intelligence.

(*b*) Geological Survey office.*

(*c*) Office of the Controller of Patents and Designs.

Provision for these offices has, however, been included in the estimate, but until the question of the location of these offices is settled, it will be impossible to design the Commerce and Industry Secretariat.

The Commerce and Industry Department in their letter no. 6843-28, dated 11th September 1912, to the Home Department state that it has been decided that for the next five years at any rate no change can be made in the location of the Stamps and Stationery Office, and that no provision to accommodate these offices at Delhi need be made. It is also stated in the same letter that the question will possibly be reconsidered in 1917, and in view of the fact that there are several other doubtful cases still to be decided, *e g.*, the location of the offices of the Director-General of Commercial Intelligence, Director, Geological Survey and Controller of Patents and Designs, it seems desirable to keep a sufficiently large area free for possible future requirements.

If there is any likelihood of the Stamps and Stationery office being moved within even ten years, some provision should be made for it in the estimate, as the cost would form a charge against the project. It is now decided that the Government Press will ultimately, but gradually, be moved to Delhi. It would therefore appear that a part of the cost of the new press buildings should also form a part of the main project. Possibly the cost of any new buildings constructed at Delhi for the press during the next ten years should be included. Instructions should be issued on these points before the preparation of detailed estimates.

This estimate includes a lump sum of Rs. 50,000 for Stamps and Stationery Offices and the Press. Until further information is received it is not possible to base the cost on plinth areas as has been done in the case of other office blocks.

3. An endeavour should be made to get definite decisions on as many of these doubtful cases as possible, otherwise the planning of the new capital is likely to be interfered with. For example the offices of the Surveyor General, Litho-Photo offices and the Mathematical Instrument offices are large important blocks, if they are to be located at Delhi they should from the first be included in the general scheme. The Commerce and Industry Secretariat is also a large important building, but its design will be delayed unless a decision can be arrived at as regards the location of the offices mentioned in paragraph 2 (*c*). The same remarks refer to the Army Department Secretariat and Head Quarters buildings.

* It is now understood that no provision need be made for the Geological Survey office.

APPENDIX B.

Schedule of rates used in this estimate.

Item.	Rate.	Per	REMARKS.
	Rs. A. P.		
Plinth area rates.			
(*a*) Office buildings—			
Secretariat buildings—			
Superior class	15 0 0	sq ft.	Based on a height of two stories.
Secretariat buildings—			
Inferior class	10 0 0	"	
(*b*) Officers residences—			
Class C	5 0 0	"	
Class D to F (ii)	3 0 0	"	
Class B	2 12 0	"	
(*c*) European clerks quarters—			
Class A	2 4 0	"	
Class B, C and D	2 0 0	"	
(*d*) Indian clerks quarters—			
Class A	2 4 0	"	
Classes B and C	2 0 0	"	
Class D	1 12 0	"	
Class E	1 8 0	"	
(*e*) Menials quarters—			
For peons	1 0 0	"	
Servants quarters	1 4 0	"	

Miscellaneous rates and percentages.

The rent of each rentable building is calculated as being 6 per cent per annum of the capital outlay. 3½ per cent per annum being the amount that is returned to Government in the form of interest, the remaining 2½ per cent being expended on annual and special repairs.

The maximum permissible rent that can be charged a government official is 10 per cent of his salary. In the case of officials, who pay 5 per cent of their salaries for residences at Simla, the rent of their residences at Delhi should not exceed 5 per cent.

APPENDIX C.

Programme of annual expenditure.

1. This programme assumes that the expenditure on works will be distributed over five full financial years. No expenditure is shown in the year 1912-13, as any expenditure in this year will form a charge against the preliminary expenses in connection with the new capital. Should, however, it be found possible to commence the collection of materials on the site or to purchase tools and plant, the cost would come under the head of "Suspense" and would not form a debit to the works until the year 1913-14. It is anticipated that practically all the constructional work will be completed in four years. The expenditure in the fifth year (1917-18) would mainly consist of paying final bills, and the carrying out of comparatively small items of work which may have been overlooked in the previous years, or from the nature of which it may have been impracticable to execute before.

2. The following remarks are given in explanation of the amounts entered in the schedule of expenditure:—

(*a*) *Government House.*—It is assumed that designs for Government House are being now prepared, consequently it should be possible to commence the work early in the year 1913-14. It is important that this work should be energetically pushed on and it should be ready for occupation in two years. But a certain amount of expenditure is provided for after the house is ready for occupation, as certain extensions, additions and modifications are sure to be found necessary even after occupation. Any such work would of course be carried out during the absence of His Excellency the Viceroy.

(*b*) *Officers' residences*—The largest expenditure will occur during the second year. In the first year the expenditure will probably not exceed Rs. 10,00,000, as a part of this year will be spent in estimating, calling for tenders and arranging details with contractors.

(*c*) *Clerks' quarters*—The same remarks as made in the case of the officers' residences apply in an equal degree to the clerks quarters.

(*d*) *Menials' quarters.*—These form a comparatively small part of the project. The greatest expenditure is given in the 2nd and 3rd years.

(*e*) *Secretariat and other offices.*—It is assumed that only about $\frac{1}{6}$th of the total expenditure can be incurred during 1913-14, as a considerable portion of this year will be past before designs have been prepared and accepted. The majority of the expenditure would occur during the 2nd and 3rd years.

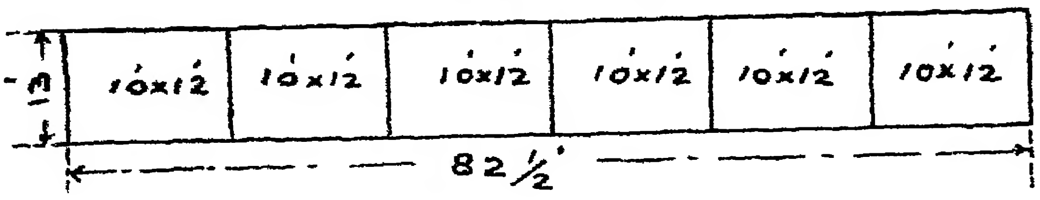
(*f*) *Miscellaneous public buildings.*—Probably very little progress will be made with buildings coming under this head for the first two years. As each particular building would require a separate estimate and sanction, and in the case of some of the buildings probably many references will have to be made to the heads of the departments concerned, the bulk of the expenditure has thus been shown under the 3rd year.

Programme of annual expenditure on buildings.

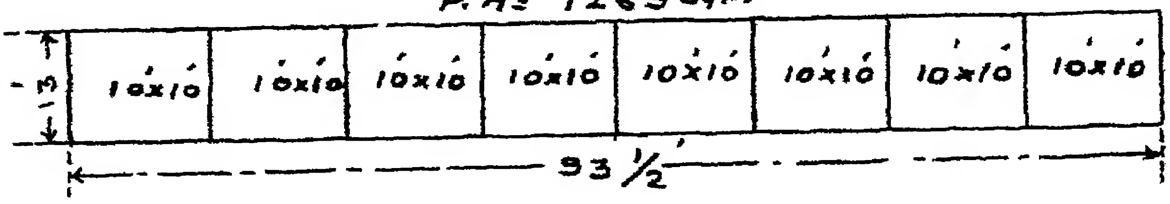
Cost of building	Cost.		Expenditure in each year.					
	As per estimate.	As a round sum.	1912-13.	1913-14.	1914-15.	1915-16.	1916-17.	1917-18.
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Government House	50,00,000*	50,00,000	...	20,00,000	25,00,000	3,00,000	2,00,000	...
Officers' residences	1,21,28,627*	52,20,000	...	10,00,000	25,00,000	10,00,000	5,00,000	2,20,000
Clerks' residences		69,00,000	...	10,00,000	25,00,000	20,00,000	12,00,000	2,00,000
Menials' quarters	2,69,340	2,70,000	...	70,000	1,00,000	1,00,000	...	...
Secretariats	86,03,030	86,00,000	...	15,00,000	35,00,000	25,00,000	5,00,000	6,00,000
Miscellaneous public buildings ...	4,89,000	5,00,000	...	50,000	50,000	1,50,000	1,00,000	1,70,000
Total Rs. ...	...	2,64,90,000	...	56,20,000	1,11,50,000	60,50,000	25,00,000	11,70,000

* Exclusive of cost of land.

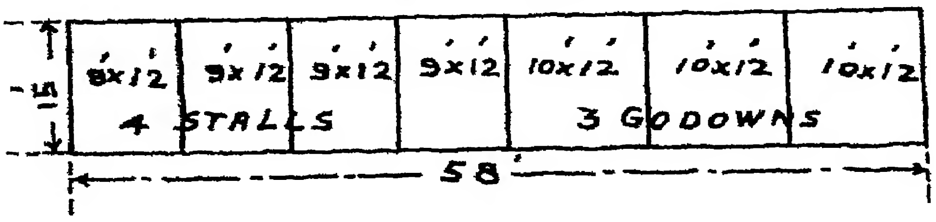
6 SERVANTS QUARTERS
P.A.= 1121 sq ft



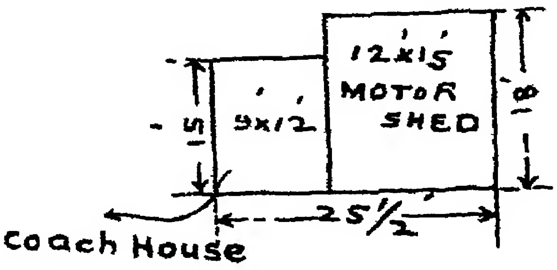
8 SERVANTS QUARTERS
P.A.= 1269 sq.ft

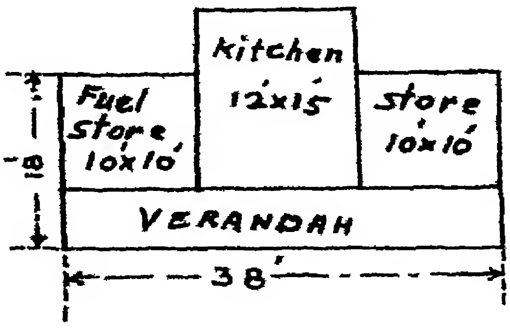


P.A. = 907 sq.ft.



P.A.= 448 sq.ft.



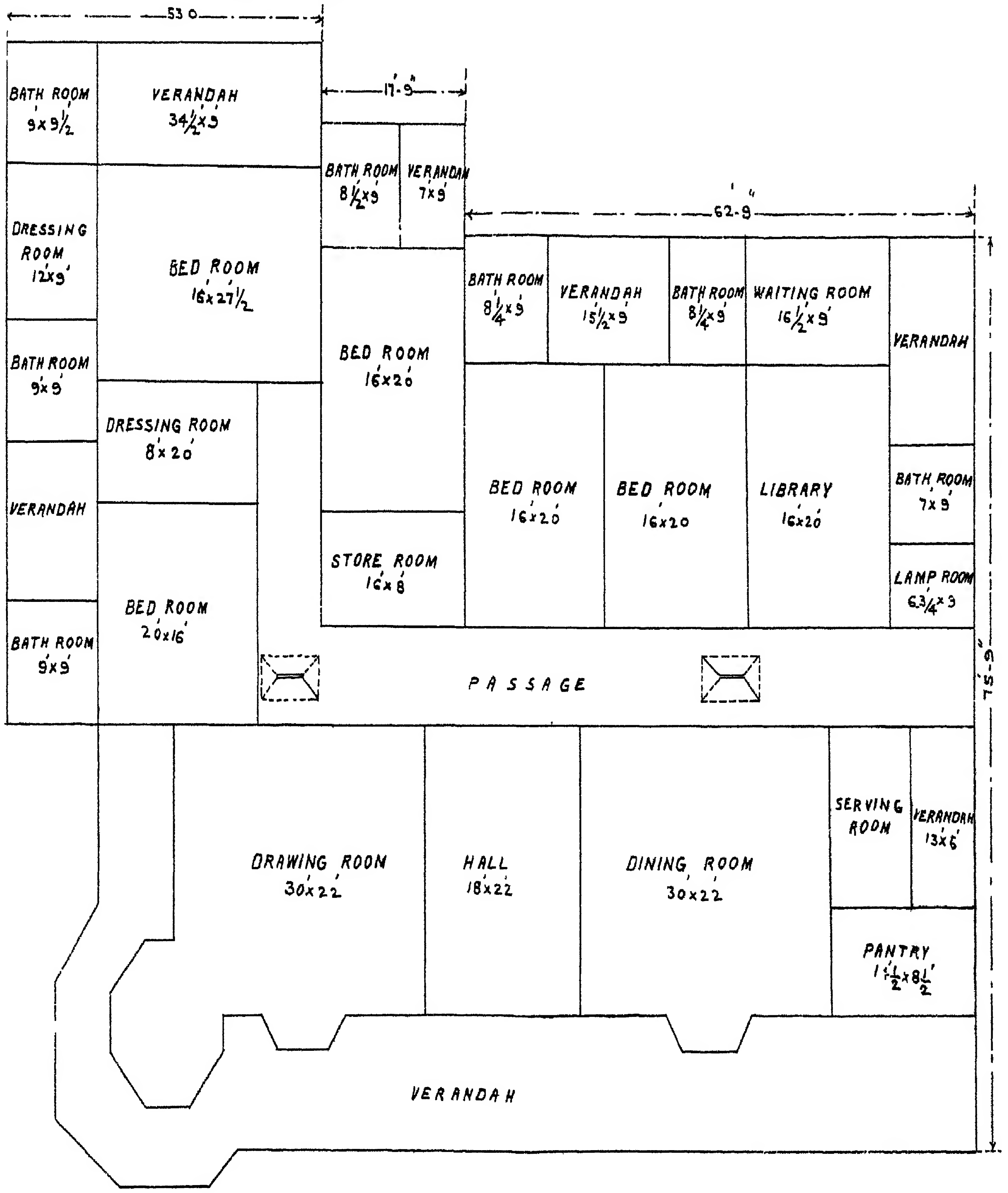


P.A.= 758 sq.ft.

Photo.-Mechl. and Litho Dept., Thomason College, Roorkee. —No 9462-3 50

CLASS .C.

OFFICERS QUARTERS

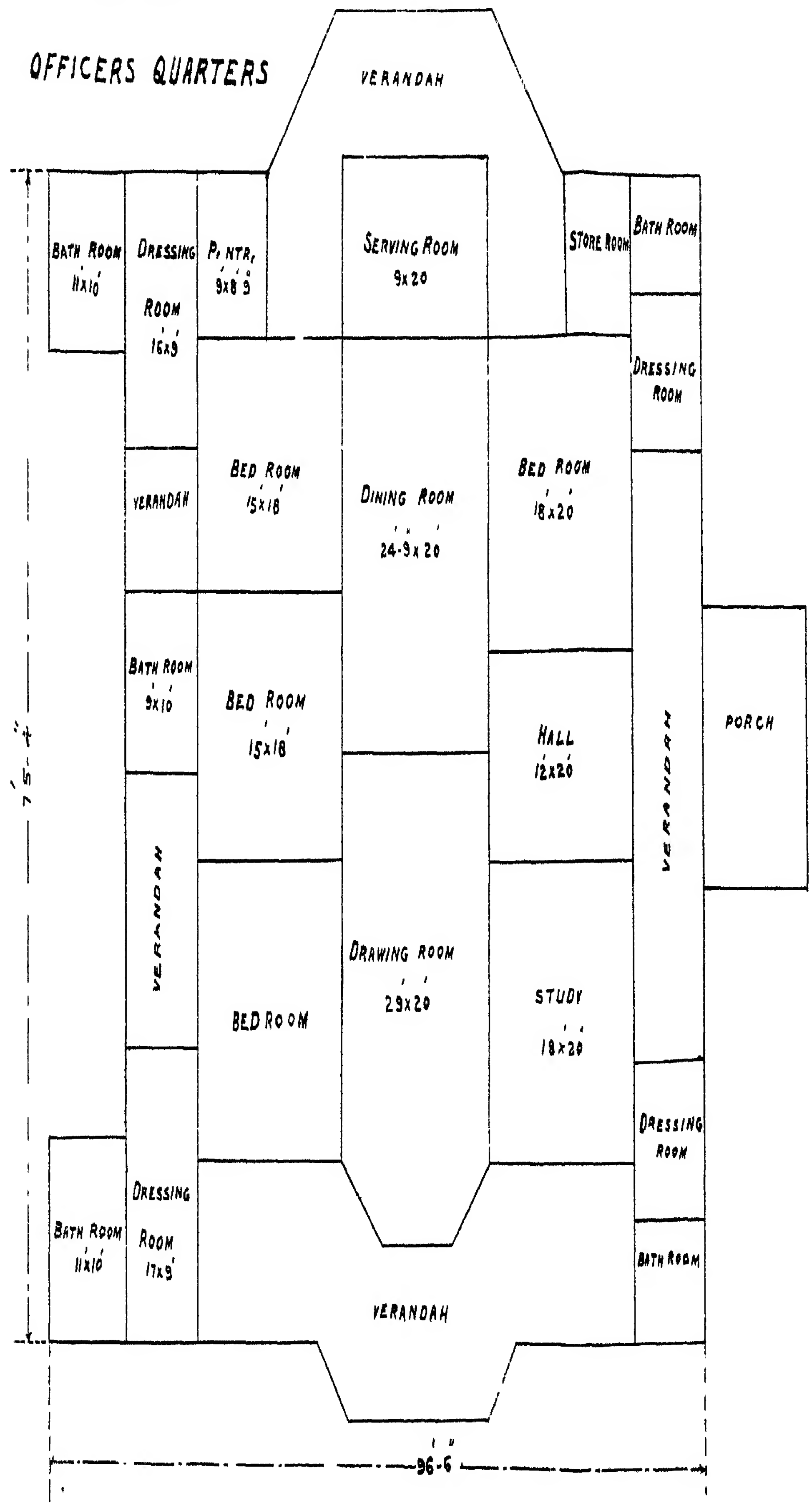


ESTIMATE OF COST	PA Sq. Ft	RATE	Amount
Residence	9869	5/-/-	49,345
6 Servants Quarters 12'x10' each, 8 3½'x13½	1121	1/4/-	1426
8 Servants Quarters 10x10 each 9 3½'x13½	1269	1/4/-	1586
4 Stalls each 9'x12' And 3 Godowns 10'x12' each	907	1/4/-	1134
1 Coach House 9'x12' and 1 Motor shed 12'x15'	448	1/8/-	672
1 Kitchen 12'x15' And 2 Stores 10'x10' each	758	2/4/-	1705
Servants Latrines 2 seats	2	60/-/-	120
Add for contingencies, Roads, drains etc.			1012
	TOTAL Rs=		57,000

W. H. ROBERTS, Capt., R.E.,
3rd September, 1912.

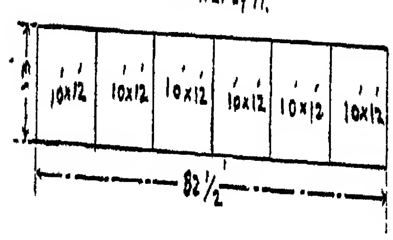
CLASS D

OFFICERS QUARTERS

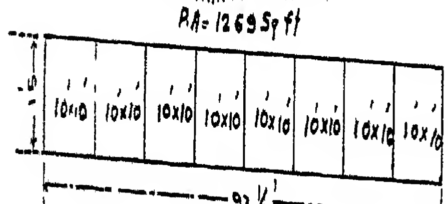


PA: 7729 Sq ft.

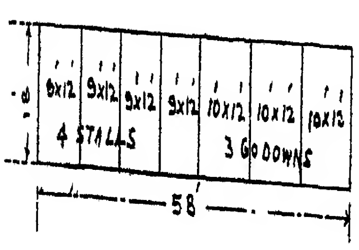
6 SERVANTS QUARTER
PA: 1121 Sq ft.



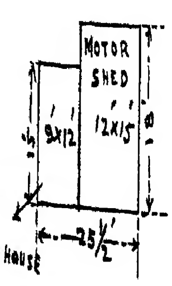
8 SERVANTS QUARTER
PA: 1269 Sq ft



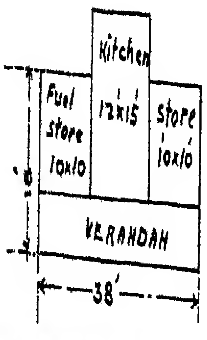
PA: 907 Sq ft.



PA: 448 Sq ft



COACH HOUSE



P.A: 758 Sq ft

ESTIMATE OF COST	PA Sq ft.	RATE	Amount
Quarters	7729	3/-/-	23187
6 Servants Quarters, 12'x10' each: 83 x 13½	1121	1/4/-	1426
8 Servants Quarters, 10x10 each = 93½ 13½	1269	1/4/-	1586
4 stalls, each 9'x12' and 3 Godowns 10'x12' each	907	1/4/-	1134
1 Coach House, 9x12 and 1 Motor Shed 12'x15'	448	1/8/-	672
1 kitchen 12'x15' and 2 Stores, 10'x10' each	758	2/-/-	1516
servants latrines, 2 seats	2	60/-	120
Add for Contingencies roads, drains, etc.	-	-	859
		TOTAL Rs.	30,500

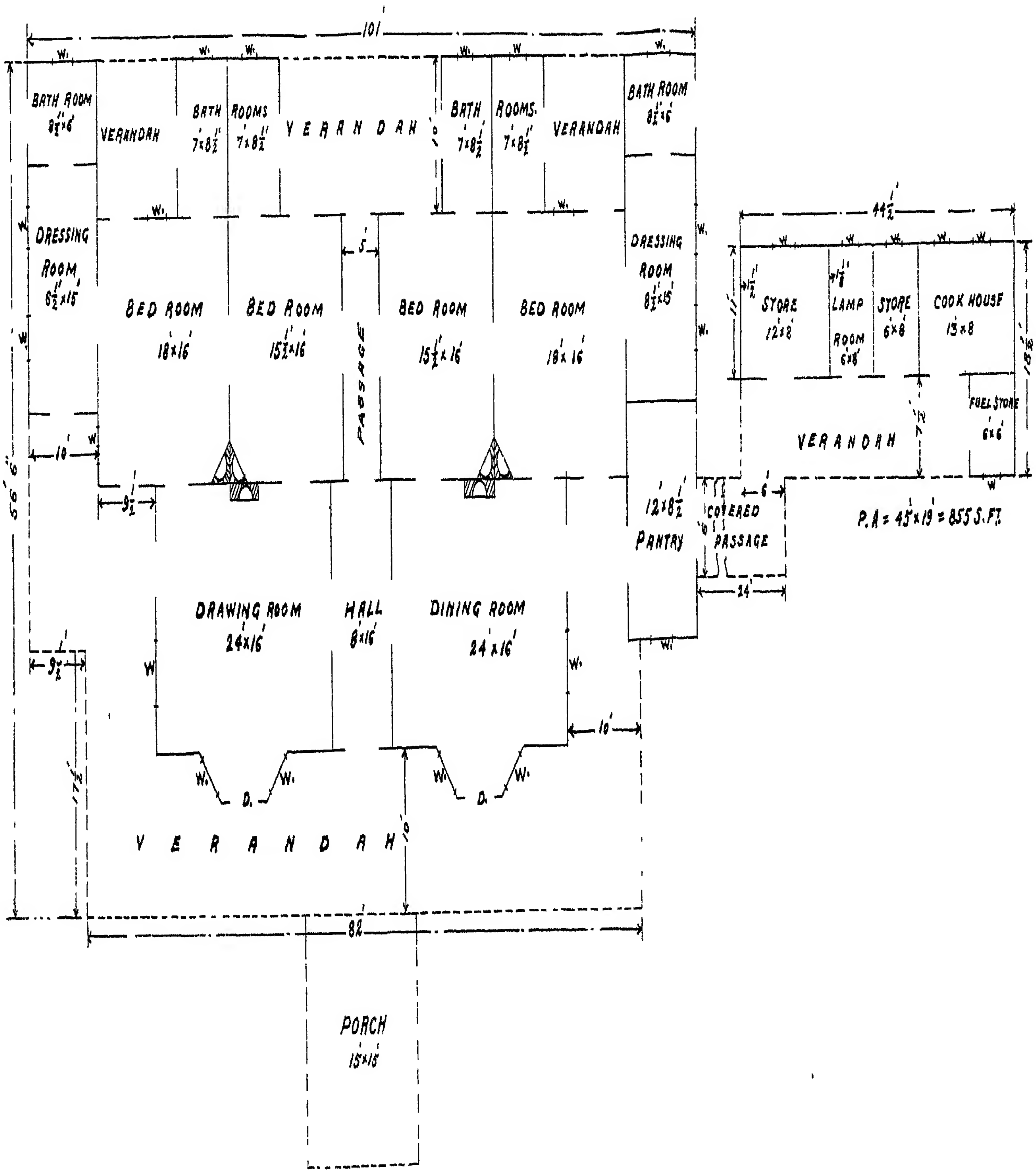
W. H. ROBERTS, CAPT., R.E.,
3rd September, 1912

Photo.-Mechl. and Litho Dept., Thomason College, Roorkee.

Zinco October, 1912.—No. 3462-E-50

CLASS. E.

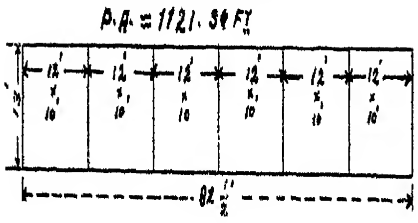
OFFICER'S QUARTERS



PLINTH AREA = $101\frac{1}{2}' \times 57' - (2 \times 17\frac{1}{2}' \times 9\frac{1}{2}')$ = 5,453 S.FT.

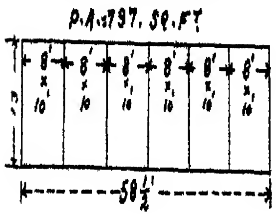
6 SERVANTS' QUARTER

P.A. = 1121. SQ FT.

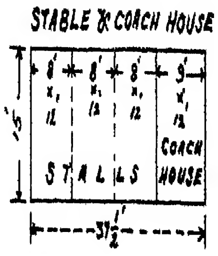


6 SERVANTS' QUARTER

P.A. = 797. SQ.FT.



STABLE & COACH HOUSE



P.A. = $38 \times 15\frac{1}{2}'$ = 589 S.FT.

ESTIMATE OF COST.

	P.A. S.FT.	RATE	AMOUNT.
QUARTER	5.453	3/-	16,359
COOK HOUSE ETC.	855	2/-	1,710
PORCH AND COVERED PASSAGE = $(15\frac{1}{2}' \times 15') + (24' \times 6\frac{1}{2}')$ =	$388\frac{1}{2}$	1/8/	583
6. SERVANTS' QRS. 10'×12' @ = 83'×13½' =	1,121	1/4/-	1,401
6. Do. 8'×10' EACH = 59'×13½'	797	1/4/-	996
3 STALLS 8'×12' EACH, 1 COACH HOUSE 9'×12'	589	1/4/-	736
SERVANTS' LATRINE 2 SEATS	2	60/-	120
ADD FOR CONTINGENCIES, ROADS, DRAINS ETC.	—	—	615
	TOTAL RS.		22,500

W. H. ROBERTS, CAPT., R.E.,
3rd September, 1912.

Photo.-Mechl. and Litho. Dept., Thomason College, Roorkee.

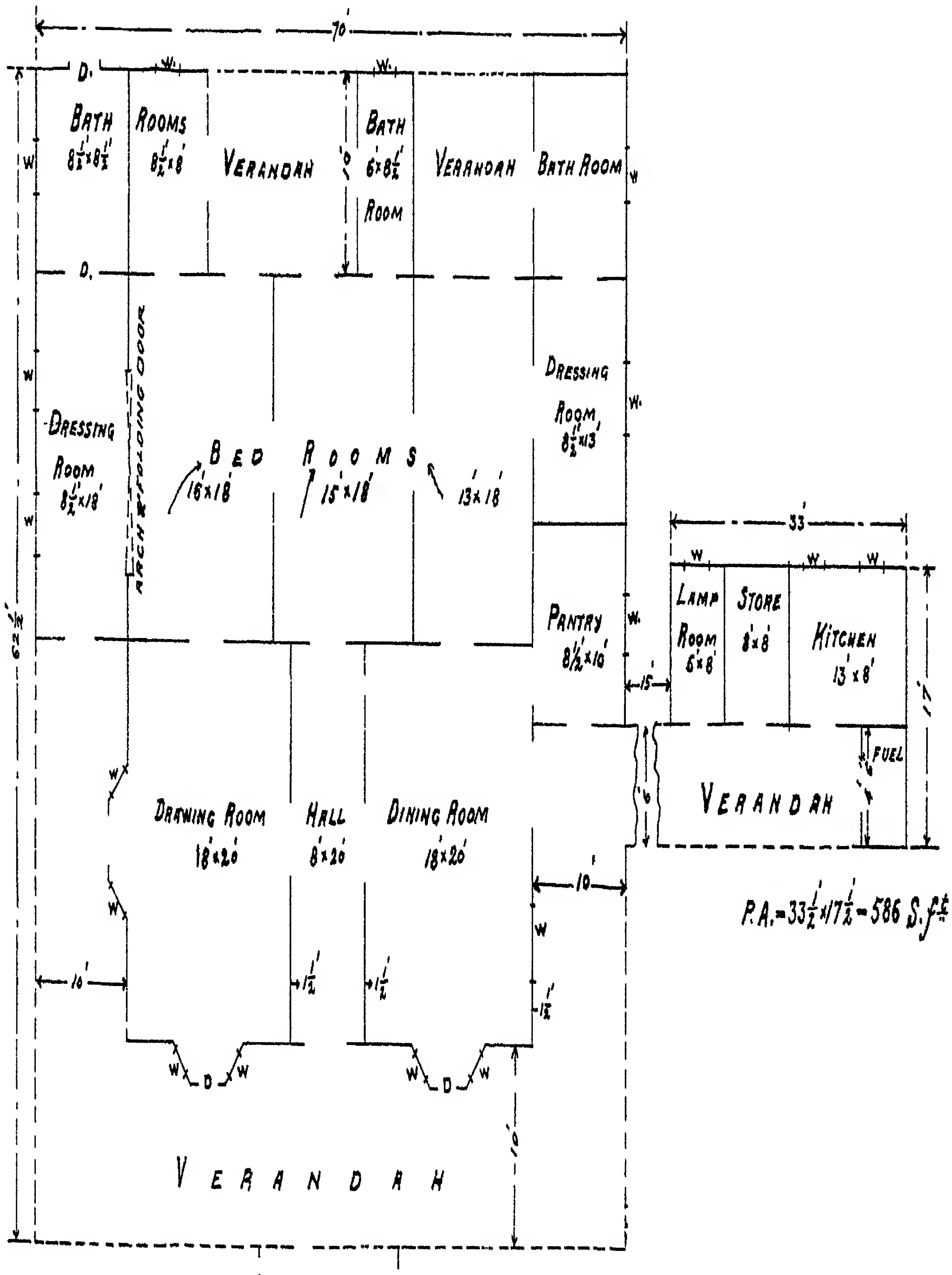
Photo.-Zinco. October, 1912.—No. 4498-J-50

CLASS F.(I)

OFFICER'S QUARTERS

PLAN

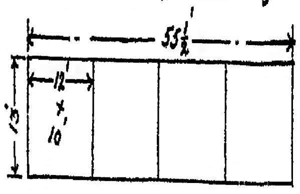
P.A. = 70½' × 63' = 4442 S.ft.



P.A. = 33½' × 17½' = 586 S.ft.

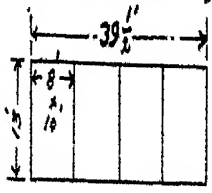
SERVANT'S QRS

P.A. = 56×13½ = 756 S.ft.



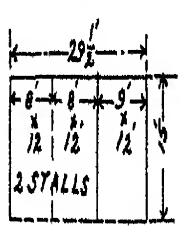
SERVANT'S QRS

P.A. = 40×13½' = 540 S.ft.



COACH HOUSE & STABLES

P.A. = 30'×15½' = 465 S.ft.



ESTIMATE OF COST.

	P.A. S.FT.	RATE	AMOUNT
Quarter	4442	3	13326
Cook House Etc.	586	2/-/-	1172
1 Coach House 9'×12' & 2 Stalls 8'×12'	465	1/4/-	581
4 Servants' Qrs. each 12'×10'	756	1/4/-	945
4 Do. " 8'×10'	540	1/4/-	675
ADD for Porch & covered passage	—	—	602
Servants' Latrine – 2 Seats	2 Seats	60/-	120
ADD for contingencies, Roads, Drains &c.	—	—	289
	TOTAL		17,710

W. H. ROBERTS, Capt., R.E.

3rd September, 1912.

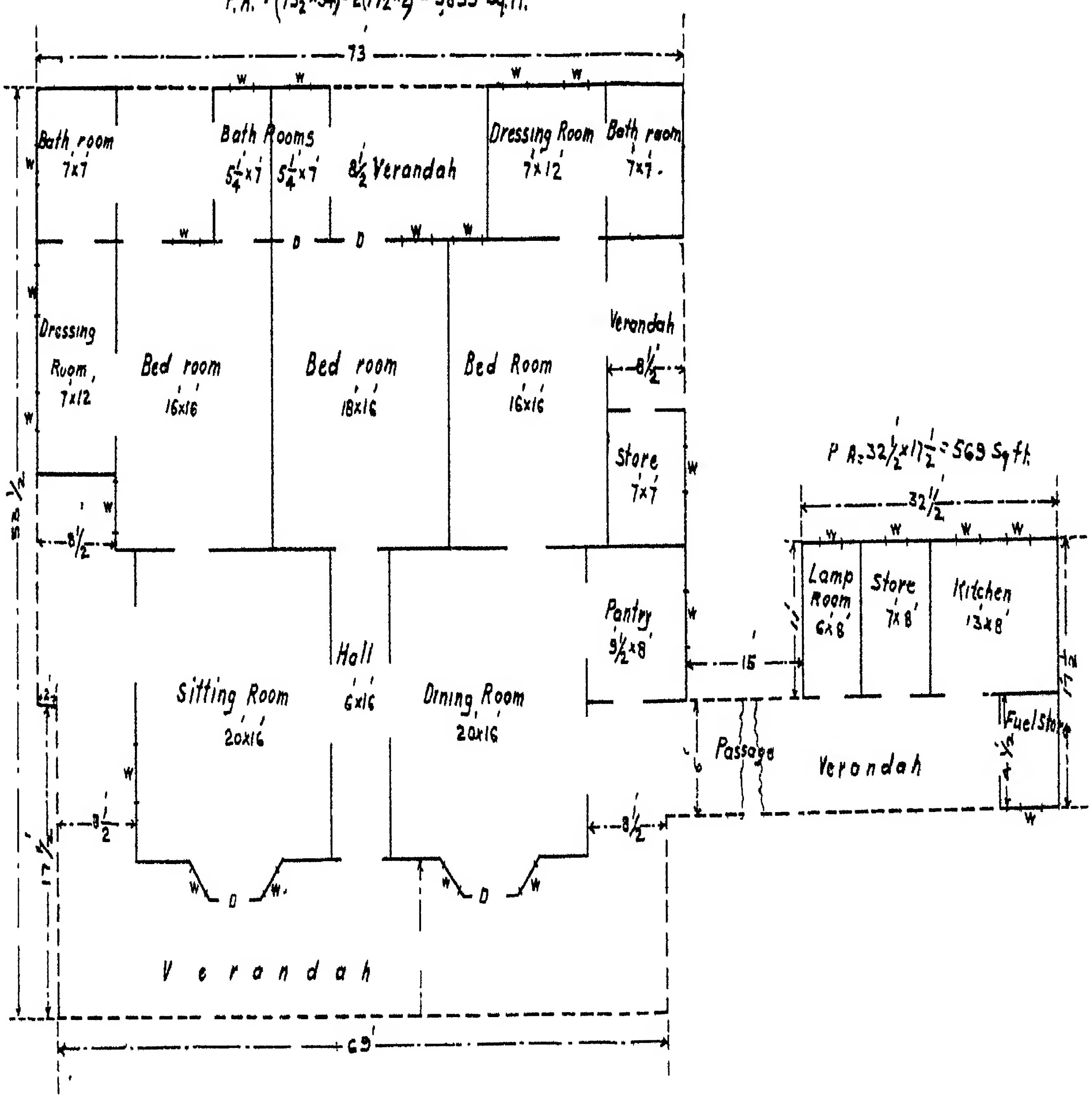
Photo.-Mechl. and Litho Dept., Thomason College, Roorkee.

Photo.-Zinco, October, 1912.—No. 4443-R-50

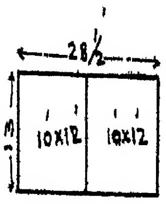
CLASS F (ii)

OFFICERS QUARTERS

P.A. = $(73\frac{1}{2} \times 54) - 2(17\frac{1}{2} \times 2) = 3899$ Sq. ft.

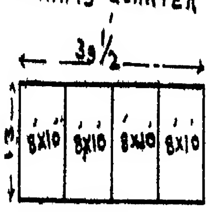


2 SERVANTS QUARTER

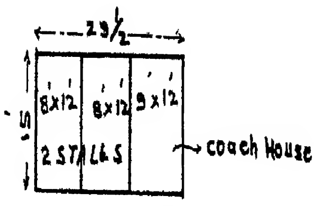


P.A. = 391½ Sq. ft.

4 SERVANTS QUARTER



P.A. = 540 sq. ft.



P.A. = 465 Sq ft

ESTIMATE OF COST

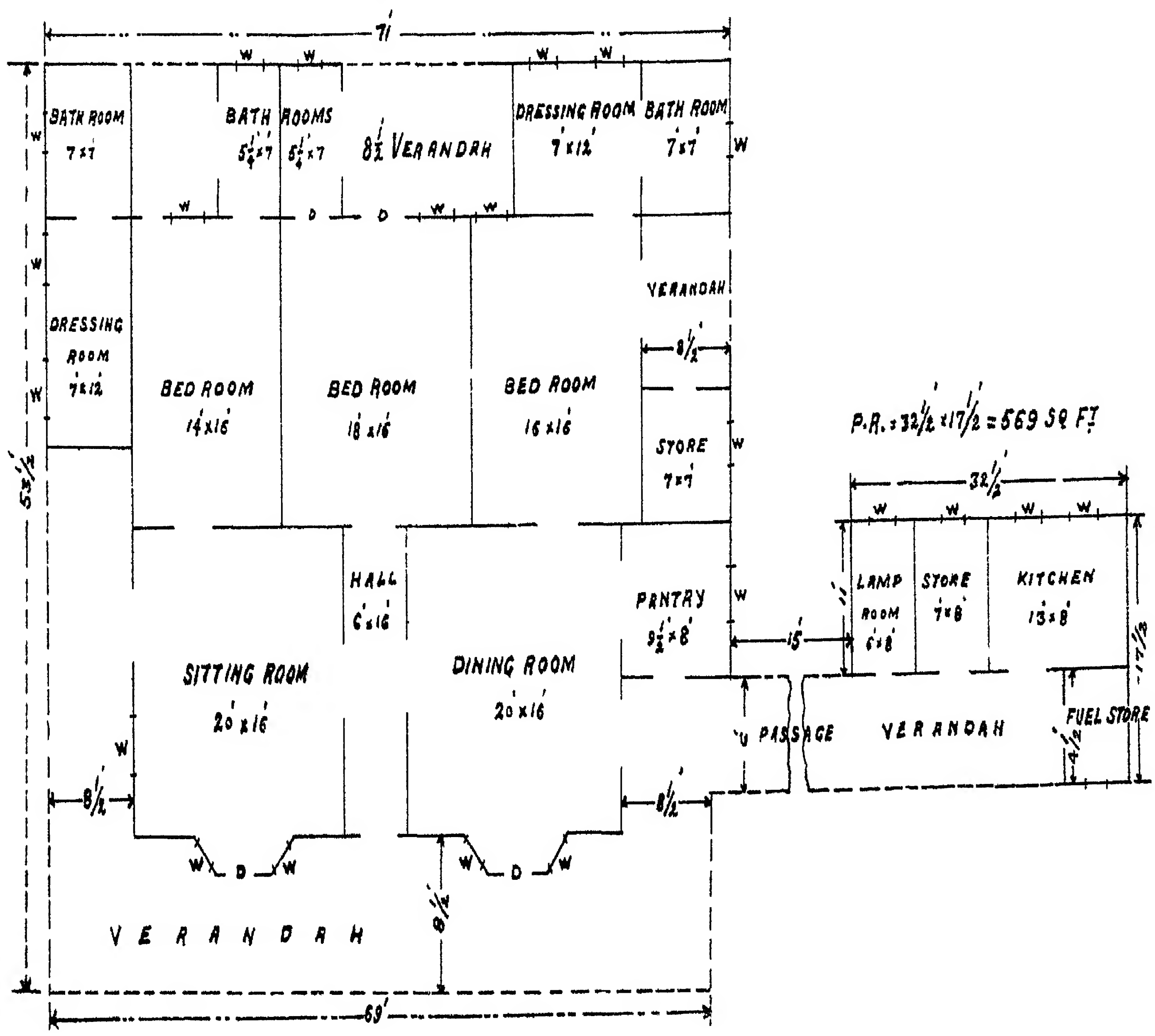
	P.A. Sft.	Rate	Amount
Quarters	3899	3/-/-	11,697
4 Servants' Quarters 8'x10' @ = 40' x 13½'	540	1/4/-	675
2 do 10'x12' @ = 29' x 13½'	391½	1/4/-	489
2 Stalls 8'x12' @ & 1 Coach house 9'x12' = 30' x 15½'	465	1/4/-	581
Kitchen &c.	569	2/-/-	1,138
Latrine for Servants 1 Seat	-	-	60
Add for contingencies, roads, drains etc	-	-	335
		Total Rs.	14,975

W. H. ROBERTS, Capt., R.E.,
3rd September, 1912.

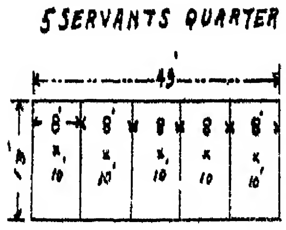
Photo.-Mechl. and Litho Dept., Thomason College, Roorkee.
Zinco, October, 1912.—No. 5468—S. 50

CLASS G
OFFICER'S QUARTERS

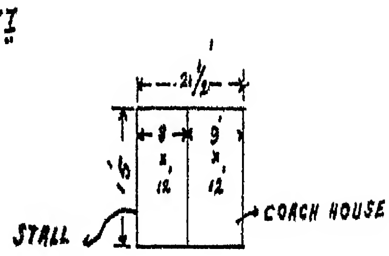
P. A. = 3826 S. FT.



5 SERVANTS QUARTER



P.A. 668 SQ FT.



P.A = 341.SQ FT.

ESTIMATE OF COST

	P.A. S.FT.	RATE	AMOUNT
QUARTERS	3826	2/12/	10521
5 SERVANTS QUARTER 8'×10' EACH = 49½'×13½'	668	1/4	835
1 STALL AND 1 COACH HOUSE	341	1/4	426
KITCHEN ETC.	569	2/	1138
LATRINE FOR SERVANTS 1 SEAT	1	60/-	60
ADD FOR CONTINGENCIES, ROADS, DRAINS ETC.	-	-	120
	TOTAL RS.		13,100

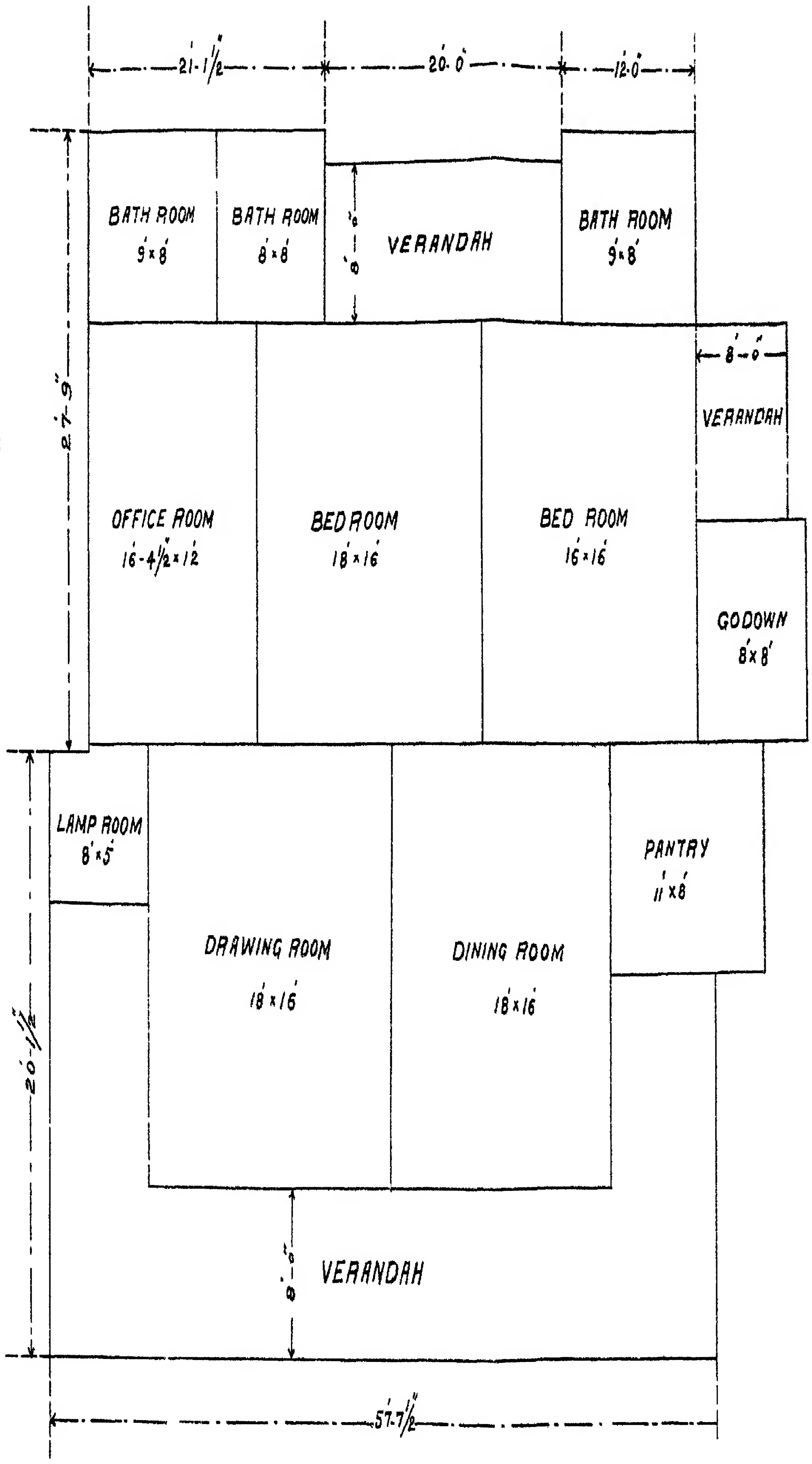
W. H. ROBERTS, CAPT., R.E.,
3rd September, 1912.

Photo-Mechl and Litho Dept., Thomason College, Roorkee.

Zinco. October, 1912.—No. 3463.10.50

CLASS A

PROPOSED RESIDENCE FOR 1 MARRIED OR 2 BACHELOR EUROPEAN SUPERINTENDENTS (GRADE RS 500)



PLINTH AREA

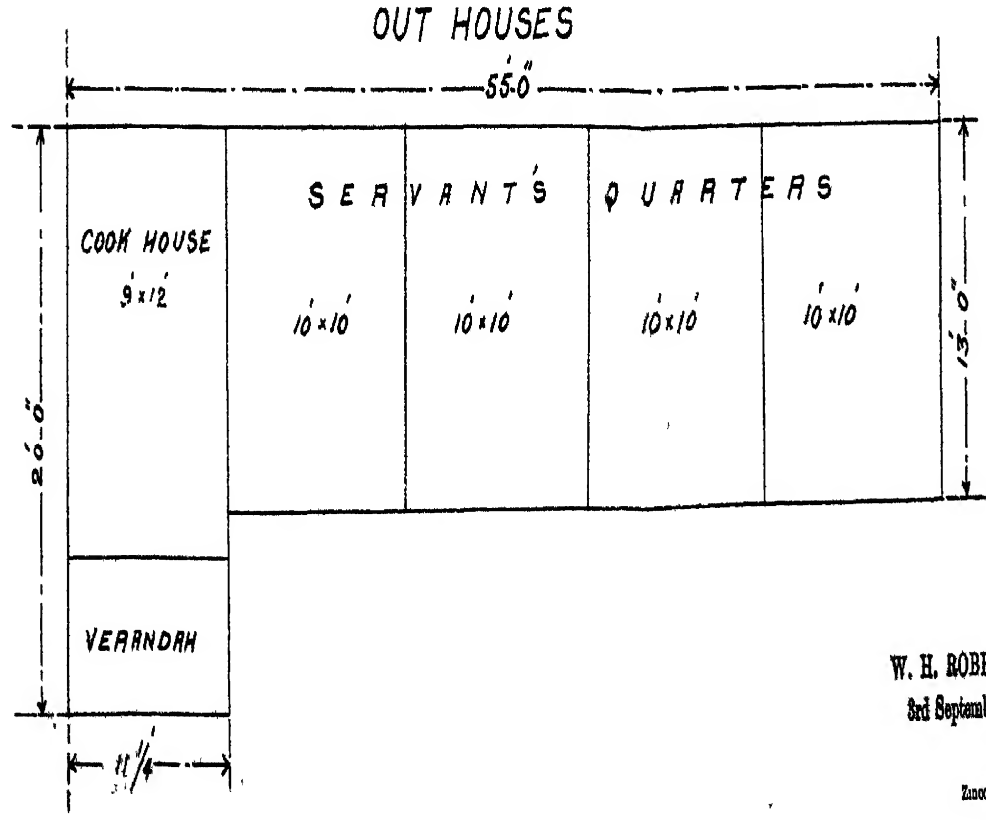
MAIN BUILDING = 3230 SQ. FT.

SERVANTS BLOCK = 828 Do Do.

ESTIMATE OF COST

	P.A. Sq. ft	RATE	Amount
Main building	3230	2/4/-	7267
Outhouses	828	1/4/-	1035
	TOTAL Rs.		8302

OUT HOUSES



W. H. ROBERTS, CAPT., R.E.,
3rd September, 1912.

Photo.-Mechl. and Litho. Dept., Thomason College, Roorkee.

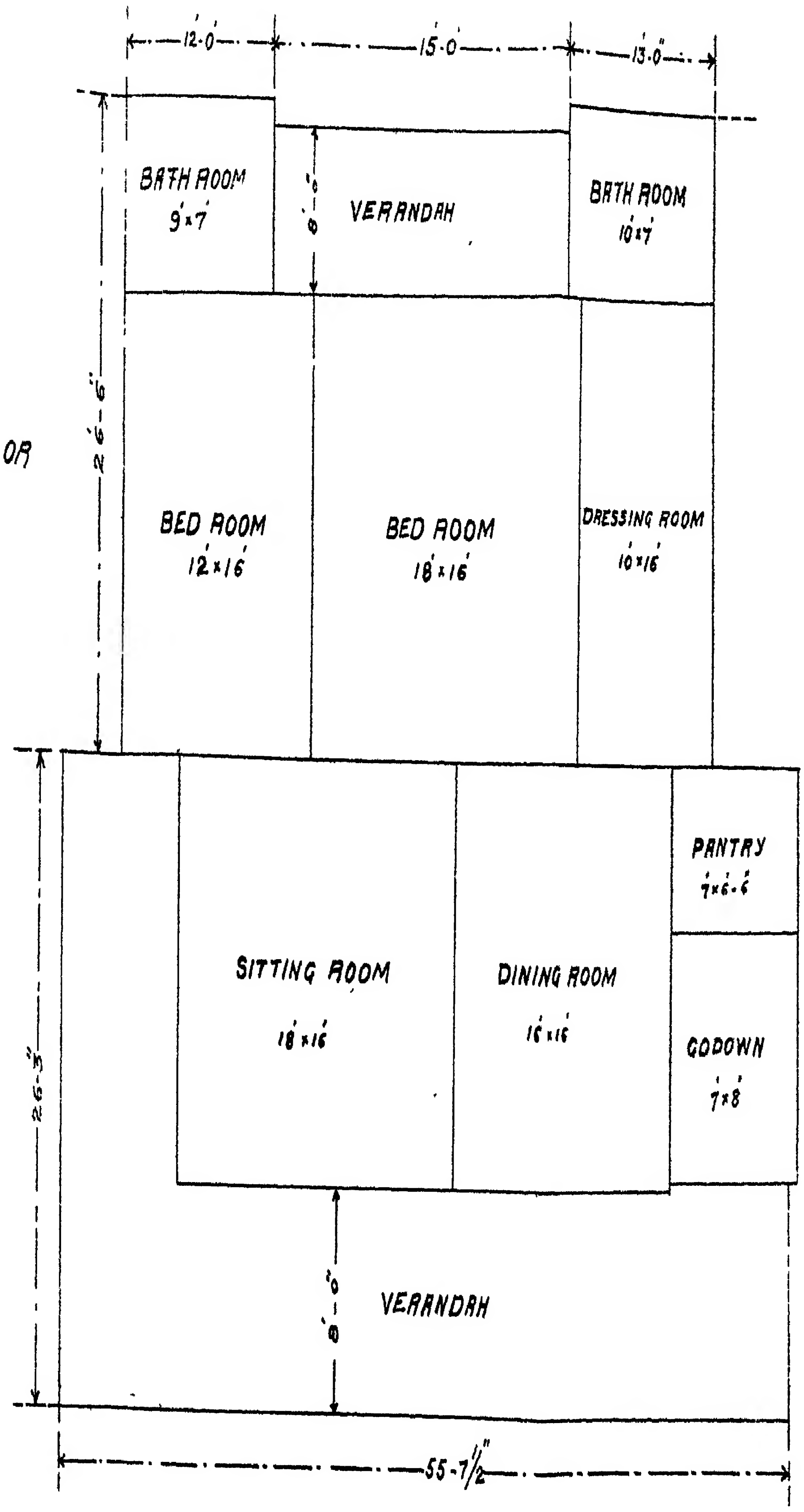
Zinco October, 1912.—No. 9463-1.36

CLASS B

PROPOSED RESIDENCE FOR 1 MARRIED OR

2 BACHELOR EUROPEAN CLERKS

(GRADE RS 301 TO RS 500)



PLINTH AREA

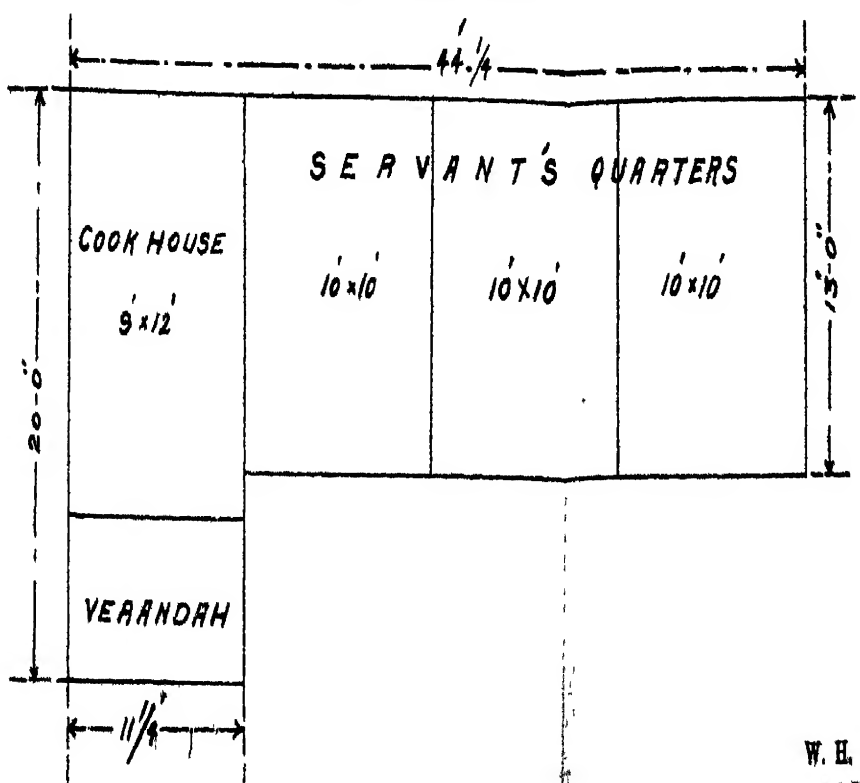
MAIN BUILDING = 2765 SQ. FT.

SERVANTS BLOCK = 683 DO DO.

ESTIMATE OF COST

	PA Sq ft	RATE	Amount
Main building	2765	2/-/-	5530
Out houses	683	1/4/-	854
		TOTAL Rs.	6384

OUT HOUSES



W. H. ROBERTS, CAPT., R.E.,
3rd September, 1912.

Photo.-Mechl. and Litho Dept., Thomason College, Roorkee.

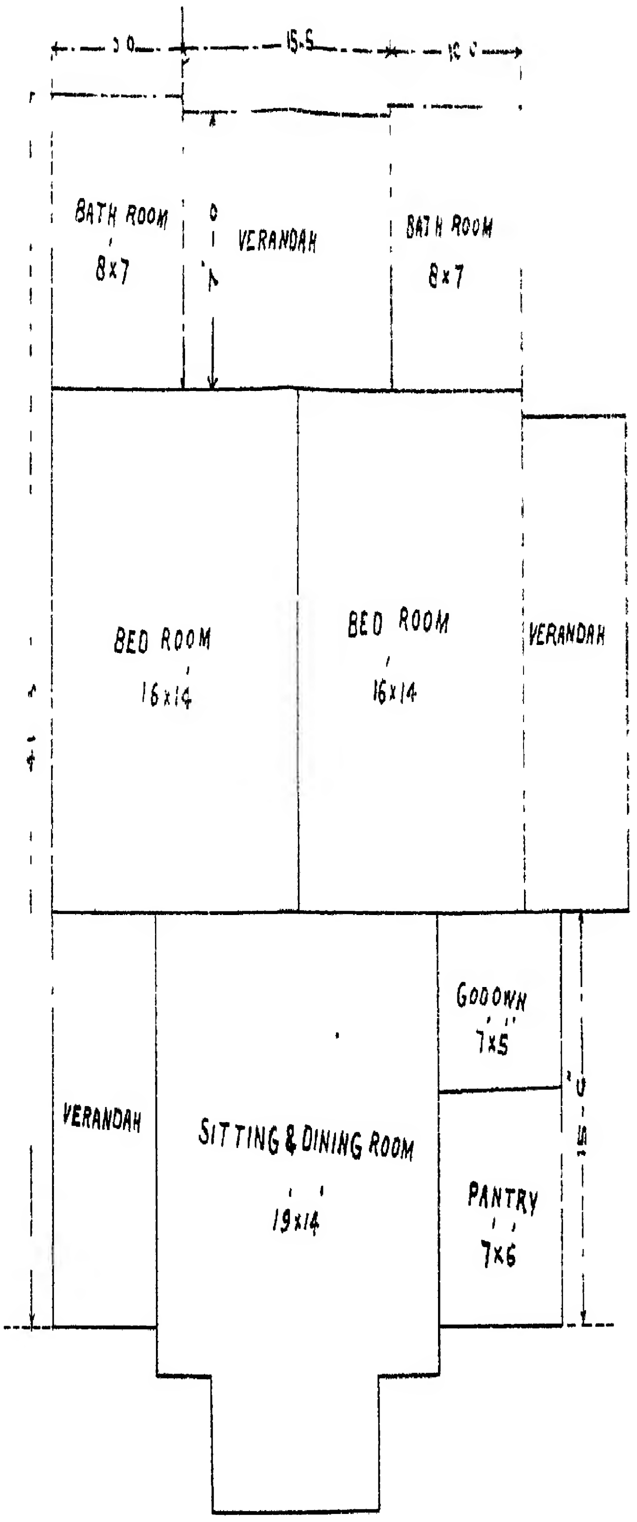
Zinco, October, 1912.—No. 9463-[illegible].

CLASS C

PROPOSED RESIDENCE FOR 1 MARRIED OR

2 BACHELOR EUROPEAN CLERKS

(GRADE Rs 201 TO Rs 300)



Plinth area

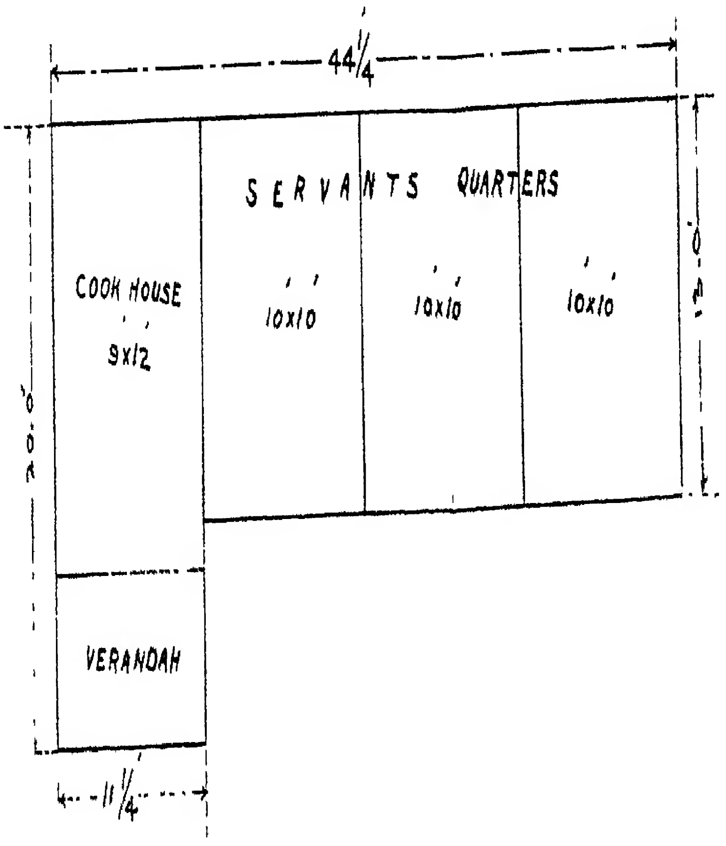
Main building = 1844 Sq.ft

Servants block = 683 Do

ESTIMATE OF COST

	P.A.S FT	RATE	AMOUNT
MAIN BUILDING	1844	2/-/-	3688
OUT HOUSES	683	1/4/-	854
		TOTAL Rs	4542

OUT HOUSES



W. H. ROBERTS, Capt., R.E.

3rd September, 1912.

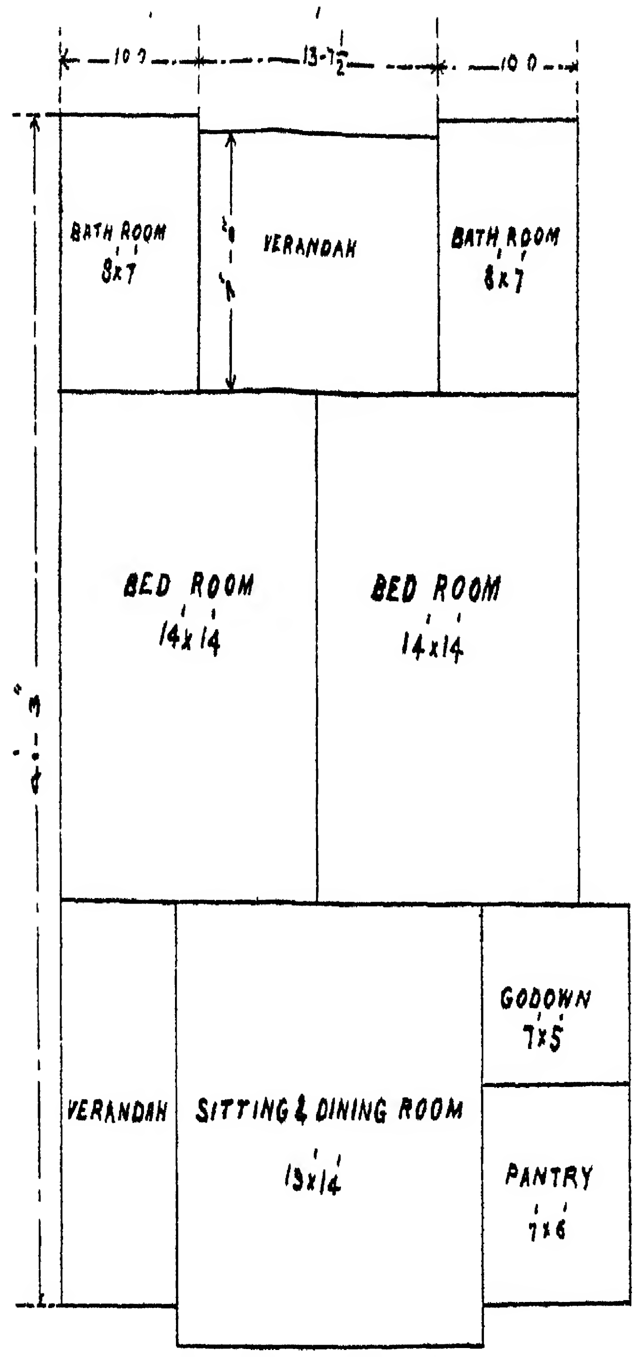
Photo.-Mech'l and Litho Dept., Thomason College, Roorkee.—No. 3468-4 53.

CLASS. D.

PROPOSED RESIDENCE FOR 1 MARRIED OR 2 BACHELOR EUROPEAN CLERKS

GRADE Rs 100 TO 200

AND UNDER Rs 100



Plinth area

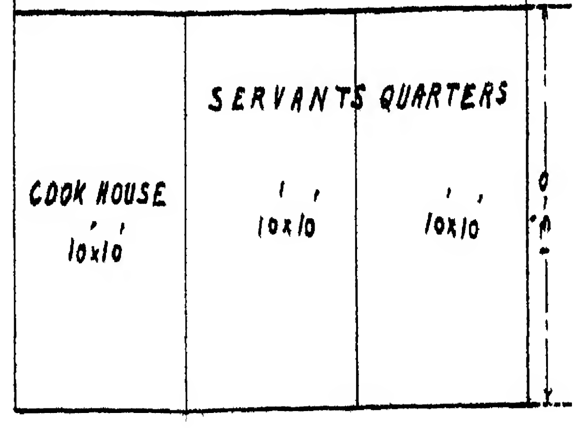
Main building. 1614 Sq. ft.

Servants block. 472 D°

ESTIMATE OF COST

	PR. S. FT	RATE	AMOUNT
MAIN BUILDING	1614	2/-/-	3228
OUT HOUSES	472	1/4/-	590
		TOTAL Rs	3818

OUT HOUSES



W. H. ROBERTS, CAPT. R.E.,
3rd September, 1912.

Photo-Mechl. and Litho Dept., Thomason College, Roorkee.

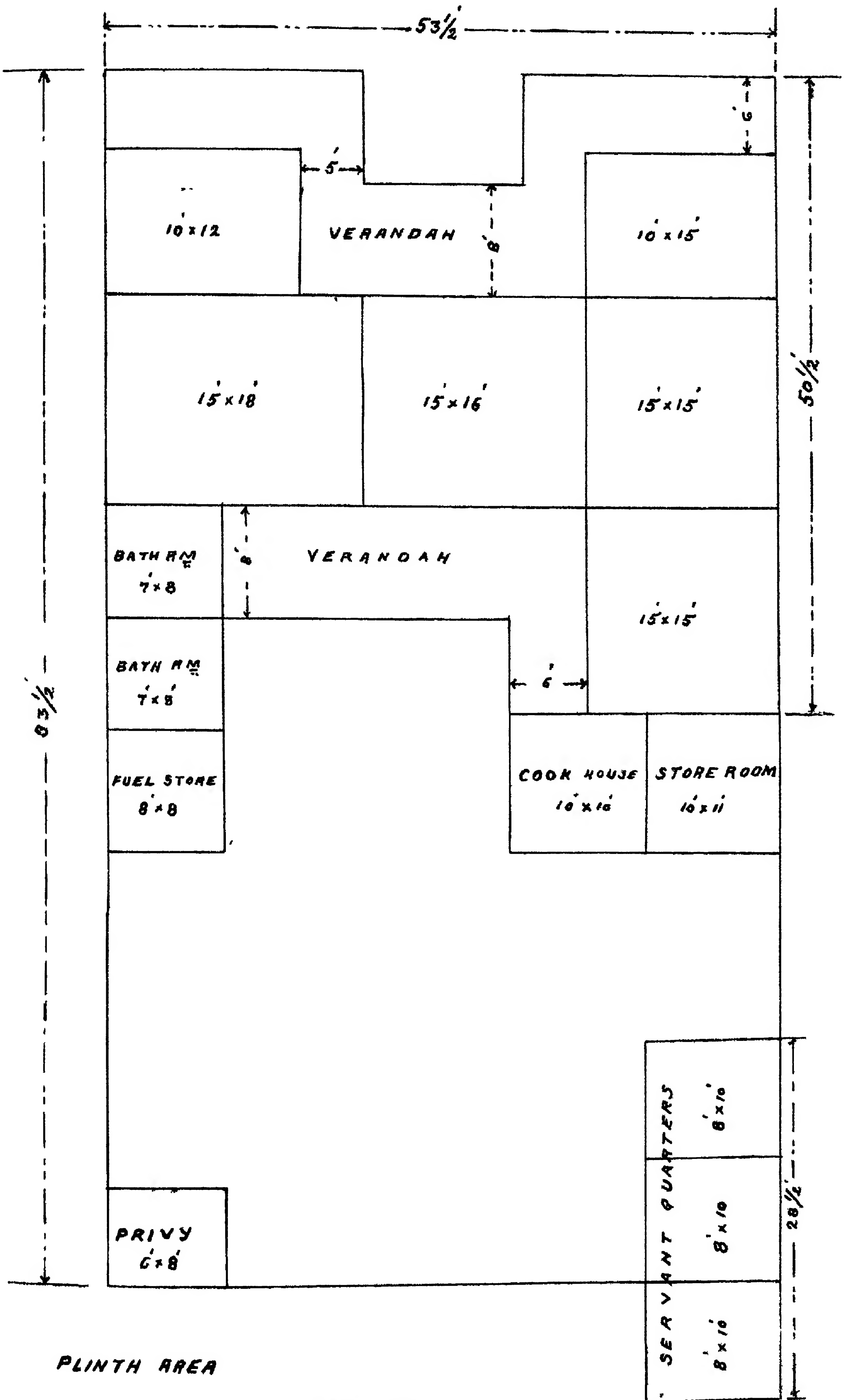
Zinco, October, 1912.—No. 3461-5-24.

CLASS A

INDIAN CLERKS QUARTER

SUPERINTENDENT ON Rs 500

SCALE 10' = 1 INCH



PLINTH AREA

MAIN BUILDING = 2439 SQ FT

OUT HOUSES = 908 SQ FT

W. H. ROBERTS, CAPT., R.E.,
3rd September, 1912

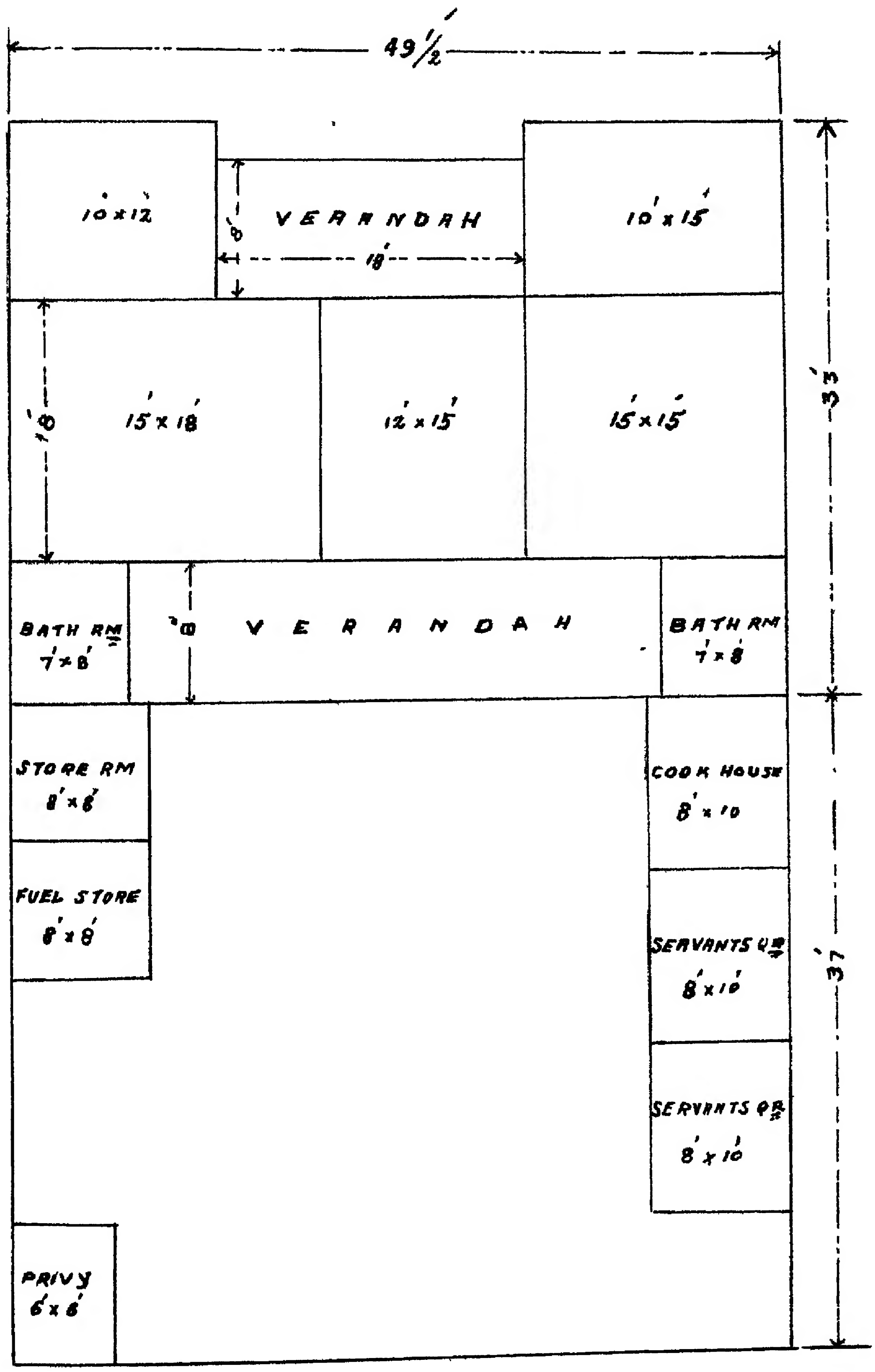
Zinco October, 1912.—No. 3463 II 50.

CLASS B

INDIAN CLERKS QUARTER

GRADE Rs 301 TO Rs 500

SCALE 10' = 1 INCH



PLINTH AREA

MAIN BUILDING 1787 SQ FT

OUT HOUSES 695 SQ FT

W. H. ROBERTS, CAPT., R.E.,
3rd September, 1912

Zinco October, 1912.—No. 9463–12. 50

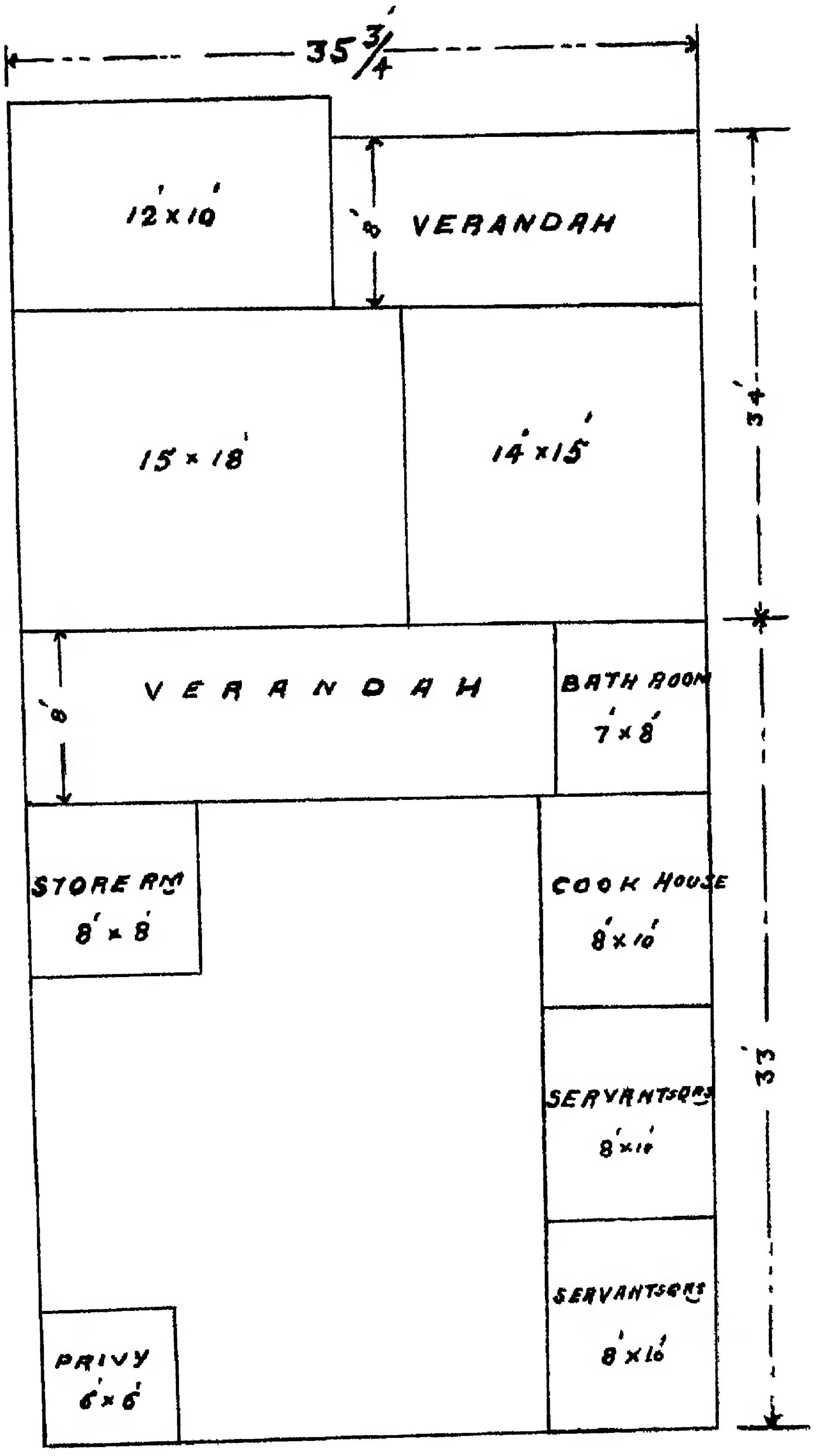
Photo-Mechl. and Litho Dept., Thomason College, Roorkee

CLASS C

INDIAN CLERKS QUARTER

GRADE RS 201 TO RS 300

SCALE 10' = 1 INCH



PLINTH AREA

MAIN BUILDING 1295 SQ FT

OUT HOUSES 594 SQ FT

W. H. ROBERTS, Capt., R.E.,
3rd September, 1912.

Zinco October, 1912 —No. 9463-350

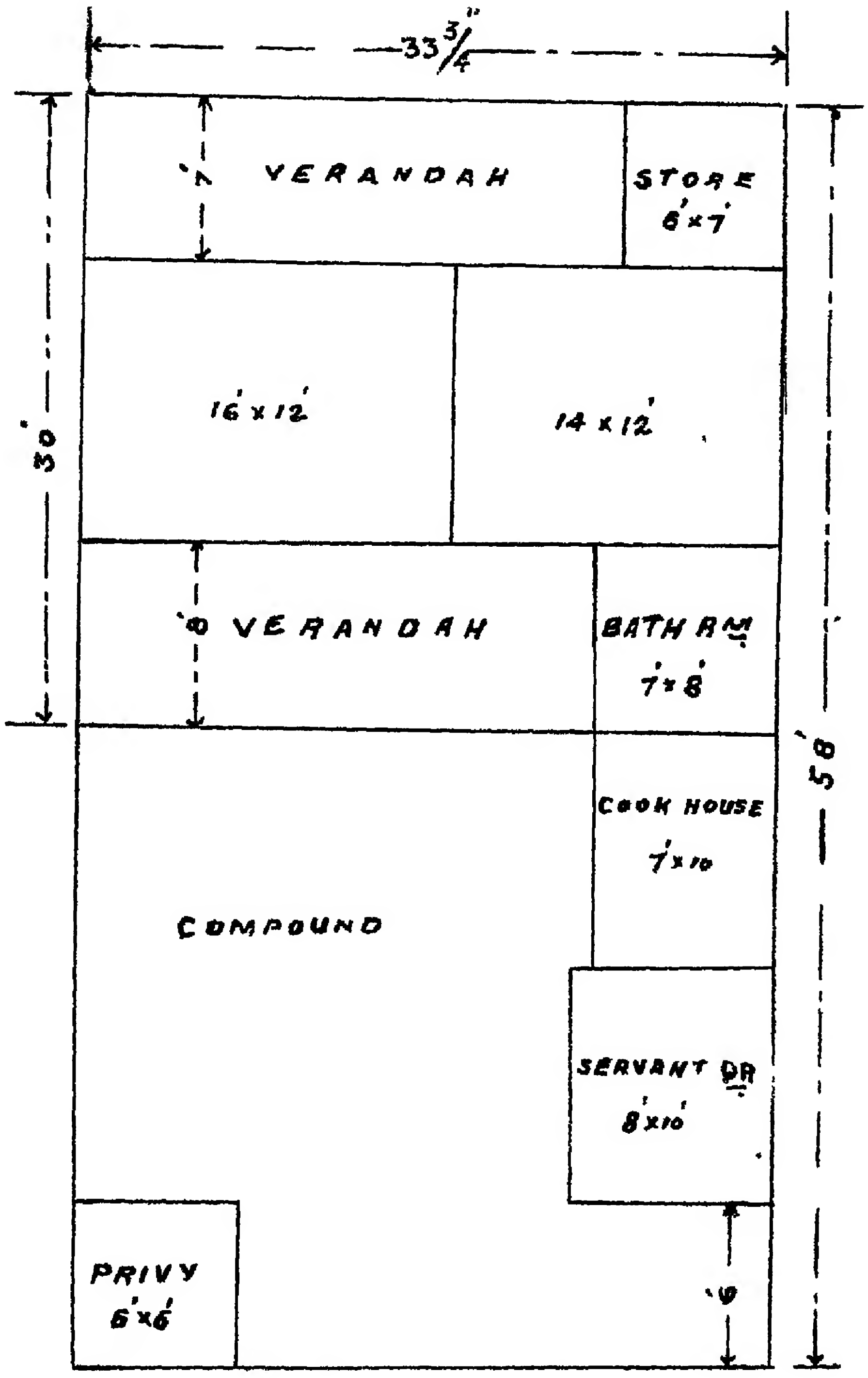
Photo.-Mechl. and Litho. Dept., Thomason College, Roorkee

CLASS D

INDIAN CLERKS QUARTER

GRADE R$\overset{s}{.}$ 100 TO R$\overset{s}{.}$ 150

SCALE 10' = 1 INCH



PLINTH AREA

MAIN BUILDING = 1027 SQ FT

OUT HOUSES = 321 SQ FT

W. H. ROBERTS, CAPT. R.E.,
3rd September 1912.

Photo.-Mechl. and Litho Dept., Thomason College, Roorkee.

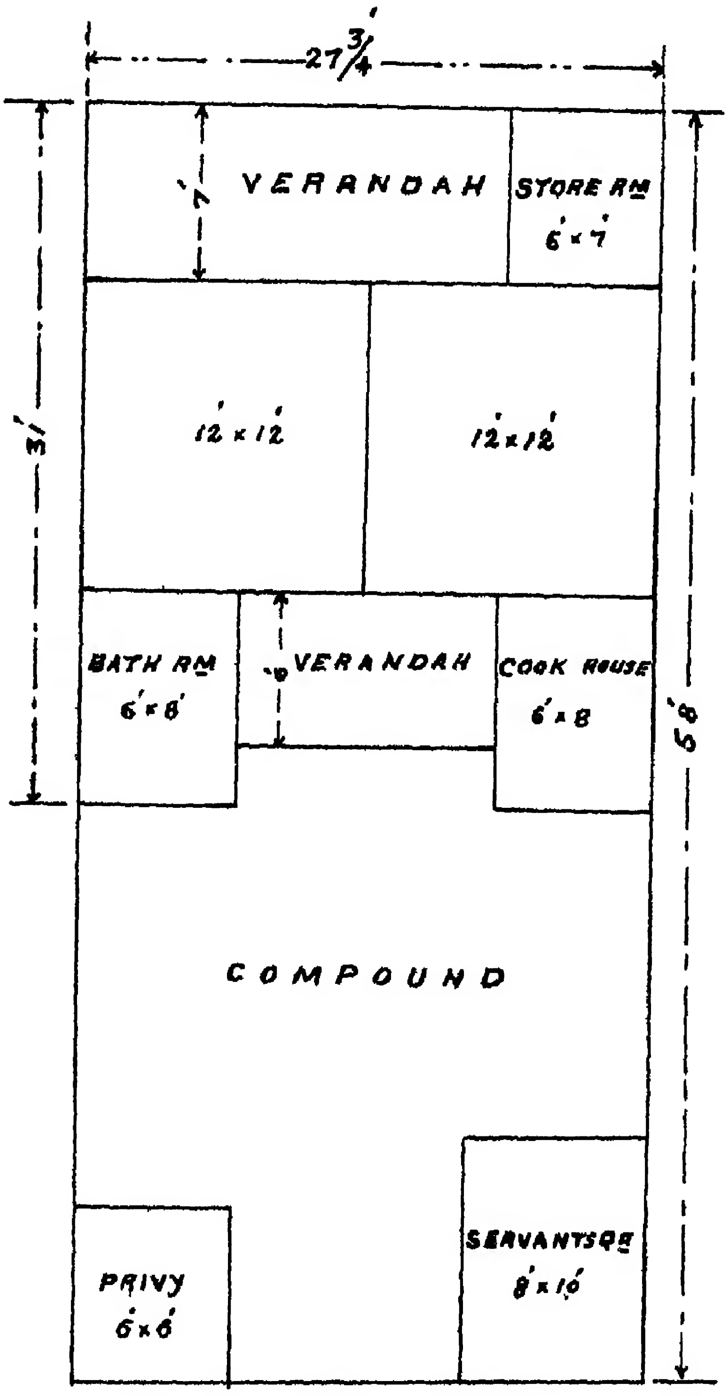
Zinco Oct—r, 1912.—No. 9463-14 50

CLASS E

INDIAN CLERKS QUARTER

GRADE RS 100 AND UNDER

SCALE 10' = 1 INCH



PLINTH AREA

MAIN BUILDING = 842 SQ FT

OUT HOUSES = 227 SQ FT

W. H. ROBERTS, CAPT., R.E.,
3rd September, 1912.

Photo.-Mechl. and Litho. Dept., Thomason College, Roorkee.

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ESTIMATE No. VIII.

Lighting ... ... Rs. 30,16,449.

708HD

Estimate No. VIII—Lighting.

Report dated the 28th September 1912, by Captain W. H. Roberts, R.E., on the cost of an electric installation.

List of Contents.

Report dated 28th September 1912, by Captain W. H. Roberts, R.E., on the cost of an electric installation.

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1. *Scope of estimate.*—This estimate provides for the installation of Electric Light throughout the New Capital. It also provides for electric fans in the more important residences and to a limited extent in the secretariat and other office buildings. It does not include the cost of power in connection with the proposed schemes for irrigation and domestic water-supply as the provision included under those headings will suffice whether steam or electric installations are employed.

2. *Sub-division of estimate.*—The estimate can for convenience be divided into the following sub-heads :—

(1) Rentable buildings.

(2) Government House.

(3) Secretariat and other offices.

(4) Street lighting.

(5) Distribution.

(6) Generating station.

A detailed estimate of cost for (1) lights and fans for rentable buildings has been prepared, the total cost of which amounts to Rs. 8,27,918, a separate report and estimate is attached which explains the provision that has been suggested and no further remarks are necessary.

The cost of an installation in Government House is based on an assumed number of points. It is quite impossible to arrive at any closer approximation until such time as detailed plans are prepared.

It is, however, possible to arrive at the cost of installing the secretariat and other office blocks by means of a plinth area rate based on the actual cost of installing the secretariat blocks of the temporary works with electric light and fans. As regards the street lighting and the distribution mains a fairly accurate figure can be arrived at by comparing the requirements of the New City with that of the late durbar. For the street lighting the number of poles, and lights is known approximately.

The cost of the generating station is the most difficult of all to estimate as the detail total output is not yet known, here again an approximation has been made.

3. *Government House.*—The largest house for which a detailed estimate has been prepared is that for a member of council which has been estimated as having 57 points for light and 8 points for fans. The residence of the Commander-in-Chief has been assumed to require double this number of points, so it may be assumed that Government House will require double that of the Commander-in-Chief's residence, that is to say 228 points for lights and 32 points for fans. The average cost per point of lighting inclusive of fitting may be taken as Rs. 50 and that for fans at Rs. 150. The total cost will therefore be—

				Rs.
228 points at Rs. 50 per point	...	...	...	11,400
32 „ „ Rs. 150 „	...	...	...	4,800
Add for special fittings ...	...	...	...	2,000
		Total	...	18,200

This is exclusive of expensive fittings on which any amount could be expended and which should perhaps be provided for under furniture.

4. *Secretariat and other office buildings.*—The approximate plinth areas of the offices one storey high are as follows :—

		Sq. ft.
Military Offices	... ...	1,58,000
Foreign Office	... ...	74,000
Home Department	... ...	50,000
Public Works Department	... ...	34,000
Education Department	... ...	38,000
Revenue and Agriculture Department	... ...	28,000
Legislative Department	... ...	30,000
Commerce and Industry Department	... ...	1,40,000
Finance Department	... ...	1,06,000
Railway Department	... ...	60,000
Post and Telegraph Department	... ...	1,00,000
Surveyor General's Office	... ...	1,48,000
Photo Litho Office	... ...	1,60,000
Mathematical Instrument Office	... ...	82,000
Town Hall	... ...	1,30,000
Press	... ... say	1,00,000
Total	...	14,38,000

In the case of the secretariat buildings of the temporary works the cost of ghting and fans amounts to approximately Rs. 31 per 100 sq. ft. of floor areas and corridors and verandahs. This rate allows for all the main rooms being lighted with electricity, but fans only for the rooms of the officers and senior clerks, but this provision would appear to be ample. The total cost under this head would therefore be Rs. 4,45,780.

5. *Street lighting.*—The following is a list of streets that it will be necessary to light—

		Miles.
200 feet broad avenues	... ...	8·18
80 " " "	... ...	9·05
60 " " roads	... ...	20·00
50 " " "	... ...	20·00
40 " " "	... ...	10·00
Total	...	67·23

For the purposes of this estimate it is assumed that the lighting will be rried out by the overhead system of distribution, and that the copper wires will carried on poles placed at 44 poles to a mile. The total number of poles would thus be $(44 \times 67{\cdot}23) = 2{,}958$ poles assuming single lines of poles. The total cost of each pole erected and including brackets for the mains and insulators will be Rs. 60. Thus the cost of poles alone will be Rs. 1,77,480.

To each pole will be attached a lighting bracket, the cost of which will vary according to the importance that is attached to the lighting of each particular avenue or road. For the main avenues, 200 feet broad, the cost allowed is Rs. 25 per bracket, for less important brackets, Rs. 15 is allowed and for inferior ones Rs. 5-8. The best class will only be allowed for the 200 feet avenues. the

intermediate class for the 80 feet avenue and the inferior class for all other roads.

The total cost would therefore be—

					Rs.
200 feet avenues	$44 \times 8{\cdot}18 \times 25 =$	...	...	...	8,998
80 „ „	$44 \times 9{\cdot}05 \times 15 =$	...	...	...	5,973
Other roads	$44 \times 50 \times 5{\cdot}5 =$	...	...	...	12,100
			Total	...	27,071

Thus the total cost of erecting the poles complete, but without the cost of any distribution mains will be Rs. 2,04,551.

6. *Distribution mains.*—The quantity of copper in the distribution mains used in connection with the Delhi Durbar was 331 tons. It is roughly estimated that the area that will actually be supplied with electricity is only about ⅓rd of that supplied by the durbar installation. If therefore it is assumed that the total amount of copper wiring required is 150 tons, the amount will be on the large side. Copper wire at present costs £80 per ton, therefore the total cost will be Rs. 1,80,000.

7. *Generating station.*—It is roughly estimated that the requirements of various portions of the new city will be as under—

Government House ...	...	...	...	50 Kilowatts.
Residencial official quarters	...	...	...	400 „ „
Rajahs, shops, bazars, etc.	...	...	...	200 „ „
Offices	...	...	...	50 „ „
Street lighting ...	...	...	...	150 „ „
Miscellaneous requirements	...	...	...	150 „ „
		Total	...	1,000 „ „

Now 1,000 kilowatts is equivalent to 1,340 H. P. It is considered that an all round rate of Rs. 1,000 per horse power will be sufficient to cover the cost of the generating plant and the power house. The amount of the durbar plant that can be usefully transferred to the installation for the New Capital is not yet known, but the rate of Rs. 1,000 is as near an approximation as can be made at this stage. The total cost of the generating station would thus be Rs. 13,40,000.

8. *Total cost.*—The total cost of supplying electricity throughout the Capital will therefore be—

				Rs.
(1) Rentable buildings as per detailed estimate (page 18)			...	8,27,918
(2) Government House ...	...	...	...	18,200
(3) Secretariat and other offices	...	...	...	4,45,780
(4) Street lighting (exclusive of mains)		...	...	2,04,551
(5) Distribution mains ...	...	...	...	1,80,000
(6) Generating station ...	...	...	...	13,40,000
		Total	...	30,16,449

9. *Programme of annual expenditure*—A certain amount of electricity will be required during the early stages of the work in connection with the running of workshops and the lighting of the quarters occupied by the constructional staff. As the secretariat offices and residences become completed, it will be convenient if the lighting can be arranged for. The expenditure will therefore be more or less evenly spread over the 5 years of construction. The expenditure on the first two years will be largely on account of articles received from England.

The programme may therefore be taken as under—

—	1913-14.	1914-15.	1915-16.	1916-17.	1917-18.	Total.
	Rs.	Rs.	Rs.	Rs	Rs.	Rs.
Total expenditure	6,50,000	6,00,000	6,00,000	6,00,000	5,66,449	30,16,449
Expenditure in England ...	4,00,000	3,00,000	1,00,000	...	...	8,00,000
Expenditure in India	2,50,000	3,00,000	5,00,000	6,00,000	5,66,449	22,16,449

10. *Points on which instructions are required.*—Points on which instructions are required can be more usefully dealt with in the general report as this estimate has been framed with the object of arriving at a sum total of money to be set aside for lights and fans for buildings and roads.

11. *Schedule of rates.*—A schedule of rates used in this estimate is added for convenience in reference.

Schedule of rates used in this estimate.

Item.	Cost.	Per.
	Rs.	
Lighting points for Government House	50	Each } inclusive of ordinary fittings only.
Fan points „ „ „	150	„ } inclusive of ordinary fittings only.
Installing lights and fans in secretariat offices ...	31	% s. ft. of floor area.
Poles complete with brackets and insulators ...	60	Each.
Lighting brackets fixed on poles—		
Best class	25	„
Intermediate class	15	„
Inferior class	5·5	„
Copper for distribution mains	1,200	Ton.
Horse power	1,000	Each.

Report on electric light fittings in rentable buildings.

This estimate provides for the cost of electric light fittings and fans in connection with all rentable buildings of the New Capital.

2. The Public Works Department in their letter no. 451-469-B., dated 20th April 1912, assessed for the next three years the annual rental for "repairs"

at 5 per cent per annum on the capital cost of the installations. In addition the occupant of a residence installed with electric light or fans has to pay a charge of $3\frac{1}{2}$ per cent per annum on account of interest. Thus the total charge made is $8\frac{1}{2}$ per cent per annnm on the capital cost of the installation.

3. An "installation" consists of all lights, fans, power connections, wires, etc., that are situated within the walls of the residence. It therefore commences from the fuse-box or distribution board. It does not include any leads or connections outside the residence.

4. The same type plans as were used in the "buildings" estimate are employed in the preparation of this estimate. An estimate of the cost of the internal fittings required in each class of bungalow has been worked out and from these results the total cost has been arrived at.

5. Although the plans selected are only types, the cost as given for each class is probably as accurate as it is possible to be without the detailed drawings of the actual residences.

6. In explanation of the various estimates the following remarks are added :—

(*a*) *Officers' class.*—Class C being the most superior class of residence proposed, the cost of wiring has been taken as Rs. 25 per point. This rate allows for a good class of casing and finish. For classes D, E, F (*i*) and F (*ii*), the wiring rate is taken as Rs. 22—this will allow for the ordinary wood casing. For Class G, where it is desirable to keep the cost of the installation as low as possible, Rs. 18 per point only is allowed, in this case the wiring will be by cleats. The estimates show the kind of fittings proposed for each class. A liberal provision of wall sockets is allowed for. These can be used for connecting up the portable lamps.

In the case of the officers quarters only, with the exception of class G, provision has been made for radiators, two in each quarter of class C and class D types and one in each quarter of classes E, and F (*i*) and (*ii*). In addition power plugs have been allowed for in the dining and drawing rooms for the connecting up of electric kettles, toasters, irons, etc. These articles would of course be provided by the occupants and not by Government. But it is considered essential that the power plugs should be installed in the first instance. The cost of these special fittings is small in comparison with that for lighting and fans.

(*b*) *European Clerks' Class.*—The cost of wiring has been taken as Rs. 18 per point as in the case of class G. officers class. The fittings will all be of a plain nature.

(*c*) *Indian Clerks' Class.*—The cost of wiring has been taken as Rs. 18 per point—all the fittings will be as plain and cheap as possible so as to reduce the annual rental to a minimum.

As regards the fittings provided for in the various estimates; the prices entered are fair average ones. A certain number of ornamental brackets and superior pendants are allowed in the case of the officers quarters, but the amounts entered are in no way extravagant. The cost of the distribution boards vary according to the size of the bungalow; Rs. 60 is allowed in the case of class C, and Rs. 50 for class D, officers scale, as these distribution boards will probably be 6 and 4 way ones respectively. For the smaller residences the cost has been reduced proportionately. In the case of smallest class of Indian clerk's quarters, which will be built in blocks, one distribution board only is provided for 5 quarters. This arrangement would probably result in economy. If each quarter was wired separately, a fuse box only in each quarter would be necessary.

7. *Fans.*—The provision made for fans in this estimate is open to some criticism, as generally speaking the majority of quarters will only be occupied during the cold months. But it is understood that the Government of India will make Delhi its headquarters for 7 months of the year, *i.e.*, from October to April inclusive. In this case fans would probably be really only necessary during the months of October and April. This being so, the question of the provision and the scale of fans needs careful consideration. This estimate however provides for ceiling fans for all the main rooms of classes C, D, E, F (*i*) and F (*ii*) officers' scale and one or two table fans for class G, officers' scale and classes A, B, and C, European clerks' scale. No provision is made for fans in the case of Class D for European clerks or in the case of Indian clerks.

8. The annual rental that should be paid by the occupants for their installation also needs consideration. The existing rules, as explained in paragraph 2, are that the occupants should pay $8\frac{1}{2}$ per cent per annum of the capital cost of their installations, but this percentage is based on the installation being used for the whole year, as a matter of fact most of the quarters will be occupied for 7 months only, consequently the cost of repairs should be less than 5 per cent. It should be ($\frac{7}{12}$th of 5) per cent, or say 3 per cent. The rate of interest at $3\frac{1}{2}$ per cent per annum would remain the same. The total charge should thus be $6\frac{1}{2}$ per cent per annum for those officers who only occupy their quarters for a little more than half the year. Statement B. however shows the percentage of rent to pay based on a return of $8\frac{1}{2}$ per cent. The above remarks are merely made to call attention to the matter.

9. Statement A is an abstract showing the total cost of installing light and fans. The number of quarters required are taken from the "buildings" estimate.

10. The total cost is as under:

	Rs.
(*a*) Lighting and extras	6,14,472
(*b*) Fans	2,13,446
Total ...	8,27,918

11. The whole of this amount will not be unremunerative as $3\frac{1}{2}$ per cent per annum will be paid by the users as interest. The amount of this will be Rs. 28,977 per annum.

Schedule of rates used in this estimate.

Item.	Cost. Rs. A. P.	Per.	Remarks.
Points.—			
Best class	25 0 0	Each.	
Intermediate class	25 0 0	"	
Inferior class	18 0 0	"	
Distribution boards and fuse boxes	60 0 0 to 15 0 0	"	Depending upon the size of the bungalow.

Item.	Cost.	Per.	Remarks.
Fans.—	Rs. A. P.		
Ceiling fans	85 0 0	Each	
Diagonal travellers	22 0 0	„	
Regulators	18 0 0	„	
Table fans	45 0 0	„	
Radiators	60 0 0	„	
Fittings.—			
Ornamental brackets	10 0 0	„	
Plain brackets for officers' quarters ...	5 0 0	„	
„ „ „ European clerks ...	3 0 0	„	
„ „ „ Indian clerks ...	2 8 0	„	
Adjustable pendants	10 0 0	„	
Plain pendants	4 0 0	„	
Standard lamps	50 0 0	„	
Table lamps	10 0 0 and 7 8 0	„	
M. F. lamps	2 0 0	„	

OFFICERS' QUARTERS.

CLASS—C.*

	Points.
Number of points.—	
Drawing room (760 square feet)	7
Two wall sockets	2
Hall (396 square feet)	2
Dining room (660 square feet)	6
Library (320 square feet)	3
1 wall socket	1
4 bed rooms, 2 points each	8
4 wall sockets	4
1 large bed room	3
1 wall socket	1
2 dressing rooms	2
7 bath rooms	7
Passage	4
Serving room	1
Pantry	1
Verandah	3
Kitchen	1
Motor shed	1
Total ...	57 points.

* All these estimates are based on the type plan for officers and clerks, details of which are given in Estimate No. II.

DETAIL OF FITTINGS.

17 plain pendants (2 in dressing rooms, 4 in passage, 2 in hall, 5 in bed rooms, 1 in kitchen, 3 in verandah).

6 ornamental brackets (3 in drawing room, 3 in dining room).

12 plain brackets (1 in library, 1 in bed room, 1 in serving room, 1 in pantry, 1 in motor shed, 7 in bath rooms).

14 adjustable pendants (4 in drawing room, 3 in dining room, 2 in library, 5 in bed rooms).

Also allow for 1 standard lamp and 4 table lamps.

ESTIMATE FOR CLASS C.

(*a*) *Lighting.*

	Rs.
Wiring 57 points at Rs. 25 each	1,425
6 ornamental brackets at Rs. 10 each	60
12 plain brackets at Rs. 5 each	60
14 adjustable pendants at Rs. 10 each	140
1 standard lamp at Rs. 50	50
4 table lamps at Rs. 10 each	40
1 distribution board	60
54 M. F. lamps at Rs. 2 each	108
Total ...	1,943

(*b*) *Fans.*

	Rs.
Wiring 8 points at Rs. 25 each	200
8 ceiling fans at Rs. 85 each	680
2 diagonal travellers at Rs. 22 each...	44
8 regulators at Rs. 18 each	144
Total ...	1,068

(*c*) *Extras.*

	Rs.
2 radiators at Rs. 60 each	120
5 power plugs for radiators, kettles etc. at Rs. 22 ...	110
Total ...	230
Total estimate ...	3,241

OFFICERS' QUARTERS.

CLASS D.

Number of points—

	Points.
Drawing room (580 sq. ft.)	6
2 wall sockets	2
Dining room (495 sq. ft.)	5

	Points.
Hall (240 sq. ft.)	2
Study (360 sq. ft.)	2
1 wall socket	1
4 bed rooms, 2 points each	8
4 wall sockets	4
4 dressing rooms	4
5 bath rooms	5
Pantry	1
Serving room	1
Store room	1
Kitchen	1
Verandah	2
Porch	1
Motor shed	1
	47 points.

DETAIL OF FITTINGS.

12 plain pendants (4 in dressing rooms, 2 in hall, 1 in kitchen, 1 in store room, 2 in verandah and 4 in bed rooms).

2 ornamental brackets (2 in drawing room).

12 plain brackets (5 in bath rooms, 1 in pantry, 2 in dining room, 1 in porch, 1 in study, 1 in serving room, 1 in motor shed).

12 adjustable pendants (4 in drawing room, 3 in dining room, 1 in study, 4 in bed rooms).

Also allow for 1 standard lamp and 2 table lamps.

ESTIMATE FOR CLASS D.

(a) *Lighting*—

	Rs.
Wiring 47 points at Rs. 22 each	1,034
14 plain pendants at Rs. 4	56
3 ornamental brackets at Rs. 10	20
12 plain brackets at Rs. 5 each	60
1 standard lamp at Rs. 50	50
2 Table lamps at Rs. 10 each	20
Distribution board	50
43 M. F. lamps at Rs. 2 each	86
Total ...	1,496

(b) *Fans*—

	Rs.
Wiring 7 points at Rs. 22 each	154
7 ceiling fans at Rs. 85 each	595
2 diagonal travellers at Rs. 22 each	44
7 regulators at Rs. 18 each	126
Total ...	919

(*c*) *Extras*—

	Rs.
2 radiators at Rs. 60 each	120
5 power plugs for radiators, kettles, etc., etc. at Rs. 22 each ...	110
Total ...	230
Total estimate ...	2,645

OFFICERS' QUARTERS.

CLASS E.

Number of points—

	Points.
Drawing room (384 sq. ft.)	3
2 wall sockets	2
Dining room (384 sq. ft.)	3
Hall (128 sq. ft.)	1
4 bed rooms, 2 points each	8
4 wall sockets	4
Passage	1
2 dressing rooms	2
6 bath rooms	6
Pantry	1
Cook-house	1
Verandah	2
Porch	1
Store room	1
Total... ...	36 points.

DETAIL OF FITTINGS.

12 plain pendants (2 in dressing rooms, 4 in bed rooms, 1 in passage, 1 in hall, 1 in kitchen, 1 in store room, 2 in verandah).

10 plain brackets (6 in bath rooms, 1 in pantry, 2 in dining room, 1 in porch).

8. adjustable pendants (3 in drawing room, 1 in dining room, 4 in bed rooms).

Also allow for 2 table lamps.

ESTIMATE FOR CLASS E.

(*a*) *Lighting*—

	Rs.
Wiring 36 points at Rs. 22 per point	379
12 plain pendants at Rs. 4 each	48
10 brackets at Rs. 5 each	50
8 adjustable pendants at Rs. 10 each	80
2 table lamps at Rs. 10 each	20
Distribution board	30
32 M. F. lamps at Rs. 2 each	64
Total ...	1,084

(*b*) *Fans*—

	Rs.
Wiring 6 points at Rs. 22	132
6 ceiling fans at Rs. 85	510
6 regulators at Rs. 18	108
Total ...	750

(*c*) *Extras*—

	Rs.
1 radiator at Rs. 60	60
4 power plugs at Rs. 22 each	88
Total ...	148
Total estimate ...	1,982

OFFICERS' QUARTERS.

CLASSES F (I) AND F (II).

Number of points—

	Points.
Drawing room (320 sq. ft.)	3
1 wall socket	1
Dining room (320 sq. ft.)	3
Hall	1
3 bed rooms, 2 points each	6
3 wall sockets	3
2 dressing rooms	2
4 bath rooms	4
Pantry	1
Store-room	1
Kitchen	1
Verandah	1
Total ...	27 points.

DETAIL OF FITTINGS.

9 plain pendants (2 in dressing rooms, 1 in store room, 1 in kitchen, 1 in hall, 1 in verandah, 3 in bed rooms).

7 brackets (4 in bath rooms, 1 in pantry, 2 in dining room).

7 adjustable pendants (3 in drawing room, 1 in dining room and 3 in bed rooms).

ESTIMATE FOR CLASSES F (I) AND F (II).

(a) *Lighting*—

	Rs.
Wiring 27 points at Rs. 22 per point	594
9 plain pendants at Rs. 4 each	36
7 brackets at Rs. 5 each	35
7 adjustable pendants at Rs. 10 each	70
2 table lamps at Rs. 7-8-0 each	15
Distribution board	30
25 M. F. lamps at Rs. 2 each	50
Total ...	830

(b) *Fans*—

Wiring 5 points at Rs. 22	110
5 fans at Rs. 85...	425
5 regulators at Rs. 18	90
Total ...	625

(c) *Extras*—

1 radiator at Rs. 60	60
4 power plugs at Rs. 22	88
Total ...	148
Total estimate ...	1,603

OFFICERS' QUARTERS.

CLASS G.

Number of points—

	Points.
Sitting room (320 sq. ft.)	3
1 wall socket	1
Dining room (320 sq. ft.)	2
Hall (96 sq. ft)	1
2 bed rooms, 2 points each	4
1 bed room	1
1 wall socket	1
2 dressing rooms	2
4 bath rooms	4
Pantry	1
Store room	1
Kitchen	1
Total ...	22 points.

DETAIL OF FITTINGS.

15 plain pendants (3 in sitting room, 2 in dining room, 1 in hall, 5 in bed rooms, 2 in dressing rooms, 1 in store room, 1 in kitchen).

5 brackets (4 in bath rooms, 1 in pantry).

ESTIMATE.

(a) *Lighting*—

	Rs.
Wiring 22 points at Rs. 18 per point	396
15 plain pendants at Rs. 4 each	60
5 brackets at Rs. 5 each	25
1 table lamp at Rs. 7-8-0	7
Distribution board	30
21 M. F. lamps at Rs. 2 each	42
Total ...	560

(*b*) *Fans*—

	Rs.
Wiring 5 points at Rs. 18 per point	90
3 table fans at Rs. 45 each	135
Total ...	225
Total estimate ...	785

EUROPEAN CLERKS' QUARTERS.

CLASS A.

Number of points—

	Points.
Drawing room (288 sq. ft.)	3
Dining room (228 sq. ft.)	2
2 bed rooms (228 sq. ft. and 256 sq. ft.)	4
1 office or bed room	1
3 bath rooms	3
1 pantry	1
1 kitchen	1
Total ...	15 points.

DETAIL OF FITTINGS.

11 plain pendants (3 in drawing room, 2 in dining room, 4 in bed rooms, 1 in office room, 1 in kitchen.)

4 brackets (3 in bath rooms, 1 in pantry).

ESTIMATE OF COST.

(*a*) *Lighting*—

	Rs.
Wiring 15 points at Rs. 18 per point	270
11 plain pendants at Rs. 4 each	44
4 brackets at Rs. 3 each	12
Distribution board	25
15 M. F. lamps at Rs. 2 each	30
Total ...	381

(*b*) *Fans*—

Wiring 5 points at Rs. 18	90
2 table fans at Rs. 45 each	90
Total ...	180
Total estimate ...	561

EUROPEAN CLERKS' QUARTERS.

CLASS B.

Number of points—

	Points.
Sitting room (288 sq. ft.)	3
Dining room (256 sq. ft.)	2
Bed rooms (288 sq. ft.)	2
Bed room (122 sq. ft.)	1
Dressing room	1
2 bath rooms	2
Pantry	1
Cook-house	1
	13 points.

DETAIL OF FITTINGS.

10 plain pendants (3 in sitting room, 2 in dining room, 3 in bed rooms, 1 in dressing room, 1 in cook house).

3 brackets (2 in bath rooms, 1 in pantry).

ESTIMATE OF COST.

(*a*) *Lighting*—

	Rs.
Wiring 13 points at Rs. 18 per point	234
10 plain brackets at Rs. 4 each	40
3 brackets at Rs. 3 each	9
Distribution board	25
13 M. F. lamps Rs. 2 each	26
Total ...	334

(*b*) *Fans*—

	Rs.
Wiring 4 points at Rs. 18 per point	72
1 table fan at Rs. 45	45
Total ...	117
Total estimate ...	451

EUROPEAN CLERKS' QUARTERS.

CLASS C.

Number of points—

	Points.
Combined sitting and dining room (266 sq. ft.)	3
2 bed rooms (224 sq. ft. each)	2
2 bath rooms	2
Pantry	1
Cook room	1
	9 points.

DETAIL OF FITTINGS.

6 plain pendants (3 in sitting room, 2 in bed room, 1 in cook house)

3 brackets (2 in bath rooms, 1 in pantry).

ESTIMATE OF COST.

(*a*) *Lighting*—

	Rs.
Wiring 9 points at Rs. 18 per point	162
6 plain pendants at Rs. 4 each	24
3 brackets at Rs. 3 each	9
Distribution board	25
9 M. F. lamps at Rs. 2 each	18
Total ...	238

(*b*) *Fans*—

	Rs.
Wiring 3 points at Rs. 18 per point	54
1 table fan at Rs. 45	45
Total ...	99
Total estimate ...	337

EUROPEAN CLERKS' QUARTERS.

CLASS D.

Number of points—

	Points.
Combined sitting and dining room (266 sq. ft.)	3
2 bed rooms (224 sq. ft. each)	2
2 bath rooms	2
Pantry	1
	8 points.

DETAIL OF FITTINGS.

5 plain pendants (3 in sitting room, 2 in bed rooms).

3 brackets (2 in bath rooms, 1 in pantry).

ESTIMATE OF COST.

(*a*) *Lighting—*

	Rs.
Wiring 8 points at Rs. 18 per point	144
5 plain pendants at Rs. 4 each	20
3 brackets at Rs. 3 each	9
Distribution board	25
8 M. F. lamps at Rs. 2 each	16
Total ...	214
Total estimate ...	214

INDIAN CLERKS' QUARTERS.

CLASS A.

Number of points—

	Points.
6 living rooms	6
Cook-house	1
	7 points.

ESTIMATE OF COST.

	Rs.
Wiring 7 points at Rs. 18 per point	126
7 plain fittings at Rs. 2-8 each	18
Distribution board	15
Total ...	159

CLASS B.

Number of points.

	Points.
5 living rooms	5
Cook-house	1
	6 points.

ESTIMATE OF COST.

	Rs.
Wiring 6 points at Rs. 18 each	108
6 plain fittings at Rs. 2-8 each	15
Distribution board	15
Total ...	138

INDIAN CLERKS' QUARTERS.

CLASS C.

Number of points.	Points.
3 living rooms	3
Cook-house	1
Total ...	4 points.

ESTIMATE OF COST.

	Rs.
Wiring 7 points at Rs. 18 per point	72
4 plain fittings at Rs. 2-8 each	10
Distribution board	15
Total ..	97

CLASS D.

Number of points.	Points.
2 living rooms	2
Cook-house	1
Total ...	3 points

ESTIMATE OF COST.

	Rs.
Wiring 3 points at Rs. 18 per point	54
3 plain fittings at Rs. 2-8 each	8
Distribution board	15
Total ...	77

CLASS E.

Number of points—	Points.
2 living rooms	2
Cook-house	1
Total ...	3 points.

ESTIMATE OF COST.

	Rs
Wiring 3 points at Rs. 18 per point	54
3 plain fittings at Rs. 2-8 each	8
Share of distribution board for 5 quarters	10
Total ...	72

STATEMENT A.

Abstract estimate showing the cost of electric light fittings and fans for rentable buildings.

Class of quarter.	Number of quarters required.	Cost of Internal fittings of each residence. (a) Lighting	(b) Fans.	(c) Extras.	Total cost. (a) Lighting (b) Extras.	(b) Fans.
	No.	Rs.	Rs.	Rs.	Rs	Rs.
Officers' Class						
Class C.	6	1,943	1,068	230	13,038	6,408
Class D.	17	1,496	919	230	29,342	15,623
Class E.	65	1,084	750	148	80,080	48,750
Class F (i) and F (ii) ...	133	830	625	148	1,30,074	83,125
Class G. ...	29	560	225	...	16,240	6,525
Total ...	...	...	...	...	2,68,774	1,60,431
European Clerks' Class.						
Class A.	59	381	180	...	22,479	10,629
Class B.	96	334	117	...	32,064	11,232
Class C.	139	238	99	...	33,082	13,761
Class D.	216	214	...	...	46,224	...
Total ...	...	...	...	...	1,33,849	35,622
Indian Clerks' Class.						
Class A.	13	159	...	...	2,067	...
Class B.	38	138	...	...	5,244	...
Class C.	77	97	...	...	7,469	...
Class D.	456	77	...	...	35,112	...
Class E.	1,830	72	...	...	1,31,760	...
Total ...	...	...	...	...	1,81,752	...
Staff of His Excellency the Viceroy.						
Officers' Class.						
Class E.	1	1,084	750	148	1,232	750
Class F (i) and F (ii)	7	830	628	148	6,846	4,375
Total ...	...	...	...	...	8,078	5,125
Commander-in-Chief and Staff.						
Commander-in-Chief	1	3,886	2,136	460	4,346	2,136
Officers' Class.						
Class E.	1	1,084	750	148	1,232	750
Class F (i) and F (ii)	2	830	625	148	1,956	1,250
Aides-de-Camp	4	...	...	...	900	500
Indian Clerks' Class.						
Class B.	1	138	...	...	138	...
Total ...	...	...	...	...	8,572	4,636

STATEMENT A—*contd.*

Abstract estimate showing the cost of electric light fittings and fans for rentable buildings.

Class of quarter	Number of quarters required.	Cost of internal fittings of each residence			Total cost.	
		(a) Lighting.	(b) Fans	(c) Extras.	(a) Lighting. (b) Extras	(b) Fans.
	No.	Rs.	Rs	Rs	Rs.	Rs
Administrative and Municipal Staff.						
Officers' Class.						
Class D.	1	1,496	919	230	1,726	919
Class E.	1	1,084	750	148	1,232	750
Class F (i) and (ii)	7	830	625	148	6,846	4,375
European Clerks' Class						
Class A.	1	381	180	...	381	180
Class B.	5	334	117	...	1,670	585
Indian Clerks' Class						
Class B	1	138	...	...	138	...
Total ...	...	...	..	...	11,993	6,809
Miscellaneous List.						
Officers' Class.						
Classs F (ii)	1	830	625	148	978	625
European Clerks' Class						
Class C.	2	238	99	...	476	198
Total ...	...	...	...	...	1,454	823
Grand total ...	...	...	...	...	6,14,472	2,13,446

Rs. 8,27,918

STATEMENT B.

Statement showing annual rental of fittings.

Class of quarter.	Pay of occupant per month	Cost of each installation	Annual rental at 8½ per cent of capital cost.		Rent as a percentage of pay.
			Per annum	Per month.	
	Rs.	Rs.	Rs.	Rs	
OFFICERS' CLASS.					
Class C.	6,667	3,241	275·4	22·95	0·34
Class D....	5,000 to 3,200	2,645	224·8	18·73	0·37 to 0·58
Class E...	3,000 to 1,600	1,982	168·47	14·04	0·46 to 0·88
Class F (*i*) and F (*ii*)	1,600 to 800	1,603	136·25	11·35	0·71 to 1·42
Class G.	800	785	66·72	5·56	0·69
EUROPEAN CLERKS' CLASS.					
Class A.	500	561	47·68	3·97	0·79
Class B.	500 to 301	451	38·33	3·19	0·64 to 1·06
Class C.	300 to 201	337	28·64	2·39	0·79 to 1·19
Class D.	200 to 100	214	18·19	1·51	0·75 to 1·51
INDIAN CLERKS' QUARTERS					
Class A.	500	159	13·51	1·12	0·22
Class B.	500 to 301	138	11·73	0·98	0·19 to 0·33
Class C.	300 to 201	97	8·24	0·69	0·23 to 0·35
Class D....	200 to 100	77	6·54	0·54	0·27 to 0·54
Class E.	Under 100	72	6·12	0·51	0·64
	(Say Rs. 80.)	...	...	...	......

G. C. B. P., Simla.—No. 708 H. D.—14-11-12.—55.—D.W.

ESTIMATE No. IX.

Establishment ... ... Rs. 60,59,573.

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Estimate No. IX—Establishment.

Report dated 28th September 1912, by Captain W. H. Roberts, R. E., on the cost of establishment.

List of Contents.

Report dated 28th September 1912, by Captain W. H. Roberts, R. E., on the cost of establishment.

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1. Scope of estimate.

This estimate provides for the salaries and allowances of all classes of the staff that are likely to be employed on the construction of the new capital. It includes the cost of the committee of experts, and those engineer and other officers who are already employed on the work of preliminary investigation.

2. Basis on which estimate is prepared.

It has been assumed that the whole work can be completed by 31st March 1918. This allows for five full working years, and a part of the present financial year. The strength and the composition of the staff will vary year by year according to the amount and nature of the work to be done. A forecast of the total annual expenditure has therefore been prepared for each of the five years during which the work of construction will continue. It is assumed that no appreciable amount of work other than the collection of some material and the preparation of the project can be carried out during the present year. From the statement of expenditure (statement B) that is likely to be incurred year by year, it has been possible to arrive at the probable strength of the constructional staff.

3. Composition of staff.

It is estimated that when the building work, and consequently expenditure, are at their highest, three circles consisting each of a superintending engineer, three executive engineers and nine sub-divisional officers with their necessary subordinate staffs, will be able to cope with the work. A chief engineer for the general control of the whole work will, of course, be necessary during the whole time of construction. The staff of three circles complete will, it is considered, be required during the years 1913-14, 1914-15 and 1915-16. For the last two years the staff can be reduced by one superintending engineer and his subordinate officers, that is to say, by one complete circle. During the last year a further reduction can be made by abolishing two of the executive engineers with their staffs, thus leaving for the last year, in addition to the chief engineer, only two superintending engineers, four executive engineers and twelve sub-divisional officers. When the work is greatest the staff under the chief engineer would consist of three superintending engineers, under each superintending engineer there will be three executive engineers, and under each executive engineer, there will be three sub-divisional officers. Statement A shows in detail the composition of each office. The following remarks are, however, added in explanation.

4. Office of the chief engineer.

In addition to the ordinary staff of this office, the pay of an extra-assistant commissioner on Rs. 500 per month has been added. This officer would deal with all questions in connection with agreements, contracts, etc. The whole of this office would remain intact during the time of construction.

5. Architect's office.

An architect of some standing and recognized ability will, no doubt, be added to the staff. This estimate provides for an architect on Rs. 2,500 per month and an assistant on Rs. 600 per month. Provision for this office has only been made for the first four years.

6. Superintending engineer's office.

Provision is made for one superintending engineer on Rs. 2,000 per month, and the other two on the Rs. 1,750 scale. The total salaries of the whole office will thus be Rs. 35,808 or Rs. 32,808 according to the grade of the superintending engineer.

7. Executive engineer's office.

The average pay of an executive engineer is taken as Rs. 1,000 per month, although this figure is in excess of the average pay of imperial and provincial executive engineers. Provision has been made in the offices of the executive engineer for five british foremen for supervising work. The pay of each of these

men is taken as Rs. 450 per month. As there are 9 executive engineers, one ninth of their total pay is added to each executive engineer's office.

8 Sub divisional offices

The average monthly pay of each assistant engineer is taken as Rs. 500. This assumes that a fairly large proportion of provincial service officers will be employed. To each sub-division will be attached one sub-engineer and five lower subordinates. One supervisor and one overseer are allowed for two offices. To each sub-division will be added one storekeeper on Rs 30 per month.

9. Arboriculture and horticulture officer.

Provision under this head has been made for a superintendent of gardens and an assistant. Perhaps in a garden city higher pay may be necessary to get the talent required. The establishment can be reduced for the last two years.

10 Land acquisition office.

Provision for this office has only been made for 4 months of the present year, and for the whole of the year 1913-14, as it is assumed from the progress already made that this office will have completed its work at the end of the year 1913-14.

11 Colonisation office

Provision for this office has been made for two years only, *i.e.*, 1913-14 and 1914-15, as at the end of the year 1914-15, the whole of the inhabitants living on the site will probably have settled down in their new homes. The estimate allows for one officer on Rs 1,000 per month to carry out the work of personally seeing to the needs of each evicted family, so that no avoidable hardship will befall any of them.

12. Sanitary and medical officer.

Under this heading are included a health officer on Rs. 1,250 per month, one assistant surgeon and three sub-assistant surgeons. The assistant surgeon will be directly in charge of the hospital and dispensary. This expenditure is lavish compared to that usual on large engineering work, but the close proximity to the enclave will probably necessitate this staff.

Audit office

This estimate allows for the cost of the audit office being charged to this work in the same manner as to other works constructed from borrowed funds. But it is possible that it may be charged to "18—General Administration." The provision made is for two audit officers on Rs. 1,000 and Rs. 600 per month respectively, and for an office staff consisting of a superintendent and 26 clerks, but for the last two years the office establishment can be reduced.

13 Salaries

The salaries allowed for the officers and clerks are fair average ones and are shown in statement A. The rates of pay allowed for chaprasis, however, needs some explanation. At Delhi, it is now extremely difficult to obtain the services of a chaprasi on Rs. 8 per month, so in every case a rate of Rs. 10 per month has been entered to be on the safe side. Jemadars of peons are allowed Rs. 11 and in the case of the chief engineer's office, Rs. 12 per month.

14 Date of appointment of staff.

For the purposes of this estimate it is assumed that the engineering staff of a superintending engineer's circle will be appointed on 1st January 1913, so the pay for this staff has been provided for two months, *i.e.*, January and February. As already stated provision has been made for the full staff from 1st April 1913.

15. Extra charges against establishment estimate.

In addition to the establishment charges on mentioned above for the year 1912-13 on the following amounts should be added:—

		Rs
(1)	Salaries and allowances of the committee of experts ...	1,65,000
(2)	Office of special engineer officers in the Home Department	1,00,000
(3)	Special officers employed in connection with the new capital	1,00,000
(4)	Prizes in connection with the bungalow competitions ...	13,600
	Total	Rs. 3,77,600

and for the year 1913-14 should be added:—

	Rs.
(1) Prizes for preliminary designs for a selected secretariat	9,000
(2) Cost of fair drawing and revising the selected design $3\frac{1}{2}$ per cent on 6,00,000	18,000
(3) $1\frac{1}{2}$ per cent on Rs 80,00,000 for the design of other buildings = Rs 1,20,000 (one half only charged in this year) ..	60,000
(4) $3\frac{1}{2}$ per cent on Rs. 50,00,000 for the design of Government House	1,75,200
Total Rs.	2,62,000

and for the year 1914-15 should be added:—

(1) One half of $1\frac{1}{2}$ per cent on Rs. 80,00,000 ...	Rs	60,000

The amounts shown as salaries are those estimated up to 15th February 1913, and will probably include all expenditure under their respective headings up to that date.

The sum of Rs. 12,600 entered in connection with the bungalow competitions is the amount of prizes as stated in the conditions, and advertised in the papers. The whole of this amount will probably be paid during the present year.

As regards the competitions for the designs of secretariat buildings, a proposal has now been recommended to invite architects to submit designs for one selected block only Three rewards amounting in all to Rs 9,000 will be given to the three approved drawings. One or more of these successful competitors will then probably be called upon to submit fair drawings modified as may be necessary to suit the local conditions. The cost of this will probably be $3\frac{1}{2}$ per cent on Rs. 6,00,000, which is the approximate cost of the selected secretariat that is out to competition. No arrangements have yet been made for the design of other important buildings, but an all round rate of $1\frac{1}{2}$ per cent on the value of the remaining buildings, which are estimated at Rs. 80 00,000, is allowed. This percentage is considered sufficient for the purposes of an estimate as it is probable that all the buildings will not be given out to selected architects to design, and that the architect, for whom provision has been made in this estimate, will himself prepare the designs for several of the buildings.

The case of Government House has, however, been considered separately, and a sum of $3\frac{1}{2}$ per cent on Rs 50,00,000, which is the estimated cost of Government House and staff residences, has been included.

16. Travelling allowances.

The amount that should be allowed for travelling expenses is somewhat difficult to estimate. The allowances will probably be particularly heavy during the time of the collection of the staff on account of joining allowances. The travelling allowances of architects and engineers, from and to England, has also to be considered, but owing to the work being concentrated in one small area, the allowances should not be excessive. A percentage of 15·23 on the cost of establishment, as is usual in the Irrigation branch, has been taken as covering the probable cost under this head.

17. Office contingencies.

Office contingencies have been estimated at 6 5 per cent of the cost of establishment, a figure that also obtains in the Irrigation branch.

18. To al expenditure on works.

Statement B is an abstract of the total expenditure on works that will be incurred year by year. The figures are taken from the programmes of annual expenditure which are attached to each estimate. From the totals deductions have been made on account of large consolidated indents for english stores. These amounts are not the cost of all english materials, but only those that are ordered in very large consignments. This has been done to enable the percentages of establishment to work done to be more correctly appreciated, as the ordering of english stores on such a large scale does not need much in the way of establishment.

Statement C shows the percentage of establishment to the cost of work executed in India. It will be noticed that for the year 1912-13 the establishment amounts to Rs. 4,56,179, whereas no actual work has been carried out. For the year 1913-14, the percentage is 21·5. The reason for this somewhat high figure is that during the greater part of the year the staff will be employed in estimating and making the preliminary arrangements. For the years 1914-15 and 1915-16, the percentages drop to 9·3 and 13·6 respectively, as during these years the construction work will be at its highest. For this reason the percentage should rightly be low. For the year 1916-17 it has risen to 21·4, and for the last year it is as high as 30·7, the reason being that most of the work being completed, the staff will be engaged in the finishing up of important works, on the settling up of accounts, the writing of completion reports and works of a like nature. The total average percentage is 16·55 which would appear to be a reasonable percentage for a large project of this sort.

19 Percentage of establishment to cost of works.

The establishment charges in statement C have also been shown under their respective headings of direction, accounts and construction.

20. Sub-division of establishment charges.

The Public Works Department in their letter No. 43-A. G., dated 12th July 1910, gave the allocation of the usual 23 per cent for establishment as under :—

Direction	... ...	4·5	per cent.
Accounts	... ...	1·5	do.
Construction	... ...	17·0	do.
	Total ...	23·0	do.

The correct proportion between these heads is therefore :—

Direction	... ...	9
Accounts	... ...	3
Constructions	... ...	34

That is to say, that direction should be $\frac{9}{46}$ths, accounts $\frac{3}{46}$ths and construction $\frac{34}{46}$ths of the total cost of establishment. If these figures be applied to the present case, we have

		Rs.		Rs.
Direction $\frac{9}{46}$ths of	... ...	60,59,573	...	11,85,569
Accounts $\frac{3}{46}$ths of	... ...	do.	...	3,95,189
Construction $\frac{34}{46}$ths of	... ...	do.	...	44,78,815
		Total	Rs.	60,59,573

These figures are remarkably close to those in the statement C, which are :—

		Rs.
Direction...	... ...	12,45,877
Accounts ...	... ...	3,02,867
Construction	... ...	45,10,829
	Total ... Rs.	60,59,573

These figures tend to show that the establishment proposed is fairly correctly proportioned between these three heads.

STAETMENT A.

Detail of each office.

Designation of official.	Number.	Pay per month.	Total pay per month.	Total pay per annum.	Remarks.
		Rs.	Rs.	Rs.	
Office of chief engineer.					
Chief engineer	1	3,000	3,000		
Personal assistant to chief engineer.	1	1,000	1,000		
Total	2	...	4,000		
Office establishment.					
Superintendent	1	500	500		
Head clerk of section	1	250	250		
Head clerk of section ...	1	150	150		
Accounts clerk	1	150	150		
Clerk	1	150	150		
"	1	120	120		
"	1	100	100		
Clerks	3	80	240		
"	2	50	100		
Total ..	12	...	1,760		
Draftsmen.					
Head draftsman	1	150	150		
Assistant draftsman	1	100	100		
" "	1	80	80		
Total ...	3	...	330		
Menial establishment.					
Daftari	1	15	15		
Chowkidar	1	8	8		
Jamadar	1	12	12		
Chaprasis...	10	10	100		
Total ...	13	...	135		
Legal office.					
Extra-assistant commissioner ...	1	500	500		
Clerk	1	50	50		
Chaprasi	1	10	10		
Total ...	3	...	560		
Total ...	...	...	6,785	81,420	

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STATEMENT A—*cotnd.*

Detail of each office.

Designation of officials	Number.	Pay per month.	Total pay per month.	Total pay per annum.	Remarks.
		Rs.	Rs.	Rs.	
Architect's office.					
Architect	1	2,500	2 500		
Assistant architect	1	600	600		
Draftsman	1	400	400		
Chaprasis...	2	10	20		
Total ...	5	...	3,520	42,240	
Superintending engineer's office.					
Superintending engineer ...	1	2,000	2,000		1 to be on Rs 2,000 and 2 on Rs. 1,750.
or					
Superintending engineer ...	1	1,750	1,750		
Office establishment.					
Head clerk	1	200	200		
2nd clerk	1	100	100		
Typists	2	60	120		
Record keeper	1	50	50		
Account's clerk	1	100	100		
Total ...	6	...	570		
Draftsmen.					
Head draftsman	1	120	120		
Assistant draftsman	2	80	160		
Tracer	1	40	40		
Total ...	4	...	320		
Menial establishment.					
Daftari	1	15	15		
Chowkidar	1	8	8		
Jamadar	1	11	11		
Chaprasis	6	10	60		
Total ...	9	...	94		
Total for office of superintending engineer on Rs. 2,000.	...	...	2,984	35,808	
Total for office of superintending engineer on Rs. 1,750.	...	...	2,734	32,808	

STATEMENT A—*contd.*

Detail of each office.

Designation of official.	Number.	Pay per month.	Total pay per month.	Total pay per annum.	Remarks.
		Rs.	Rs.	Rs.	
Office of executive engineer.					
Executive engineer	1	1,000	1,000		
Office establishment.					
Head clerk	1	100	100		
2nd clerk	1	60	60		
Typist	1	60	60		
Record keeper	1	50	50		
Accountant	1	100	100		
Assistant accountant	1	60	60		
Clerks	3	50	150		
Total ...	9	...	580		
Draftsmen.					
Head draftsman	1	100	100		
Assistant head draftsman ...	1	80	80		
Draftsman	1	70	70		
"	1	60	60		
"	1	50	50		
Tracers	2	40	80		
Total ...	7	...	440		
Menial establishment.					
Daftari	1	15	15		
Chowkidar	1	8	8		
Jamadar	1	11	11		
Chaprasis	4	10	40		
Total ...	7	...	74		
British foremen of works.					
Allow for 5 men ...	...	...	...		
Each executive engineer will provide for the pay of 5/9ths of these men as nine executive engineers are suggested.	1/9th	5 × 450	250		
Total ...	...	...	2,344	28,128	

STATEMENT A—*contd.*

Detail of each office.

Designation of official.	Number.	Pay per month.	Total pay per month.	Total pay per annum.	Remarks.
		Rs.	Rs.	Rs.	
Office of sub-divisional officer.					
Assistant engineer	1	500	500		
Office establishment.					
Clerk	1	50	50		
Menial establishment.					
Chaprasi	1	10	10		
Upper and lower subordinate engineer establishment.					
Sub-engineer	1	300	300		
Supervisor	½	200	100		
Overseer	½	100	50		
Subordinates	5	60	300		
	7	...	750		
Storekeeper.					
Storekeeper	1	30	30		
Total ...	...	...	1,340	16,080	
Audit office.					
Audit officer	1	1,000	1,000		
Assistant audit officer ...	1	600	600		
Total ..	2	...	1,600		
Office establishment.					
Superintendent	1	400	400		
Assistant superintendents ...	2	200	400		
Clerks	2	150	300		
"	3	100	300		
"	4	90	360		
"	4	80	320		
"	5	70	350		
"	6	60	360		
Total ...	27	...	2,790		
Menial establishment.					
Daftari	1	20	20		
Jamadar	1	12	12		
Chaprasis	7	10	70		
Total ...	9	...	102		
Total of Audit office ...	...	...	4,492	53,904	

STATEMENT A—*contd.*

Detail of each office.

Designation of official.	Number.	Pay per month.	Total pay per month.	Total pay per annum.	Remarks.
		Rs.	Rs.	Rs.	
Office of Arboriculture and Horticulture.					
Superintendent of gardens ...	1	600	600		
Assistant superintendent of gardens	1	200	200		
Daroghas	3	100	300		
Other establishment	...	...	100		
			1,200	14,400	
Land Acquisition office.					
Land acquisition officer ...	1	1,900	1,900		
Extra-assistant commissioner ...	1	500	500		
Do. do. ...	1	300	300		
Tahsildars, office and menials ...	...	...	1,400		
			4,100	49,200	
Colonisation office.					
Colonisation office	1	1,000	1,000		
Office establishment.					
Clerks	1	60	60		
"	1	50	50		
	2	...	110		
Menial establishment.					
Chaprasi	1	10	10		
Chowkidar	1	8	8		
	2	...	18		
Total ...	...	...	1,128	13,536	
Sanitary and medical offices.					
Health officer	1	1,250	1,250		
Assistant surgeon	1	120	120		
Sub-assistant surgeons ...	3	50	150		
Hospital establishment ...	...	...	270		
Sanitary "	...	...	590		
Office "	...	...	180		
			3,560	30,720	

STATEMENT B.

Programme of annual expenditure on works abstracted from the individual estimates.

Item.	Estimate number.	1913-14.	1914-15.	1915-16.	1916-17.	1917-18.	Totals.
		Rs.	Rs.	Rs.	Rs.	Rs.	Rs
Buildings	VII	56,20,000	1,11,50,000	60,50,000	25,00,000	11,70,000	2,64,90,000
Roads and avenues	V	6,27,000	7,23,000	6,80,000	3,00,000	1,00,000	24,30,000
Irrigation	III	12,02,150	16,39,477	7,12,186	6,01,074	......	41,54,887
Domestic water-supply	IV	2,94,424	7,04,164	3,15,539	41,917	......	13,56,044
Sewers	II (*b*)	1,00,000	4,00,000	3,00,000	55,000	......	8,55,000
Storm water drains	II (*a*)	1,00,000	5,00,000	7,00,000	2,00,000	. ....	15,00,000
Sanitary installation	II (*c*)	1,68,000	2,96,000	70,000	58,000	38,000	6,30,000
Parks	VI	1,38,000	1,50,000	2,50,000	1,50,000	1,50,000	8,38,000
Electric light	VII	6,50,000	6,00,000	6,00,000	6,00,000	5,66,449	30,16,449
Tools and plant	...	2,00,000	2,00,000	1,00,000	1,00,000	......	6,00,000
	Total ...	90,99,574	1,63,62,641	97,77,725	46,05,991	20,24,449	4,18,70,380
Deduct.							
and on—							
... ...	...	9,01,612	11,23,834	5,61,917	4,50,806	......	30,38,169
ition	...	1,42,500	2,58,000	57,750	42,000	28,750	5,29,000
supply	...	2,00,000	6,38,575	......	... ..	......	8,38,575
... ...	...	4,00,000	3,00,000	1,00,000	.. ...	......	8,00,000
Total expenditure in England	...	16,44,112	23,20,409	7,19,667	4,92,806	28,750	52,05,744
Total expenditure in India	...	74,55,462	1,40,42,232	90,58,058	41,13,185	19,95,699	3,66,64,636

STATEMENT C.

Statement showing percentages of establishment to expenditure in India.

Items.	1912-13	1913-14	1914-15	1915-16.	1916-17.	1917-18.	Total.
	Rs.	Rs	Rs.	Rs.	Rs.	Rs.	Rs.
Expenditure in India	...	74,55,462	1,40,42,232	90,58,058	41,13,185	19,95,699	3,66,64,636
Expenditure on ... direction	7,195	2,73,995	2,73,995	2,73,995	8,34,058	1,92,639	12,45,877
Expenditure on ... accounts	4,869	65,654	65,654	65,654	60,865	40 171	3,02,867
Expenditure on ... construction	4,44,115	12,29,957	9,68,066	8,91,589	5,87,600	3,89 502	45,10,829
Total establishment charges	4,56,179	15,69,606	13,07,715	12 31,238	8,82 523	6,12,312	60,59,573
Percentage of establishment to expenditure in India	...	21·5	9 3	13 6	2·14	30·7	16 55

ESTIMATE.

Detail of establishment charges.

Name of office.	1912-13.	1913-14	1914-15.	1915-16.	1916-17.	1917-18.
	Rs.	Rs.	Rs.	Rs.	Rs	Rs
Chief engineer's office	......	81,420	81,420	81,420	81,420	81,420
Architect's office	......	42,240	42,240	42,240	42,240	......
Superintending engineer's office	5,968	1,01,424	1,01,424	1,01,424	68,616	68,616
Executive engineer's office	......	2,53,152	2,53,152	2,53,152	1,68,768	1,12,512
Office of sub-divisional officer	24,120	4,34,160	4,34,160	4,34,160	2,89,440	1,92,960
Audit office	4,000	53,934	53,934	53,934	50,000	33,000
Arboriculture and horticulture office	......	14,400	14,400	14,400	4,500	4,500
Land acquisition office	16,400	49,200	......	......	......	......
Colonisation office	......	13,536	13,536	......	......	......
Sanitary and medical offices	......	30,720	30,720	30,720	20,000	10,000
Total ...	64,552	10,74,186	10,24,986	10,11,450	7,24,984	5,03,008
Travelling allowances at 15·23 per cent	9,831	1,63,598	1,56,105	1,54,044	1,10,415	76,608
Office contingencies at 6·5 per cent	4,196	69,822	66,624	65,744	47,124	32,696
Total ...	78,579	13,07,606	12,47,715	12,31,238	8,82,523	6,12,312
Additional expenditure as detailed in report, paragraph 15	3,77,600	2,62,000	60,000	......	......	......
Total ...	4,56,179	15,69,606	13,07,715	12,31,238	8,82,523	6,12,312
GRAND TOTAL ...	......	......	......	......	......	Rs. 60,59,575

G. C. B. P., Simla.—No. 708 H. D.—14-11-12.—55.—N. M.